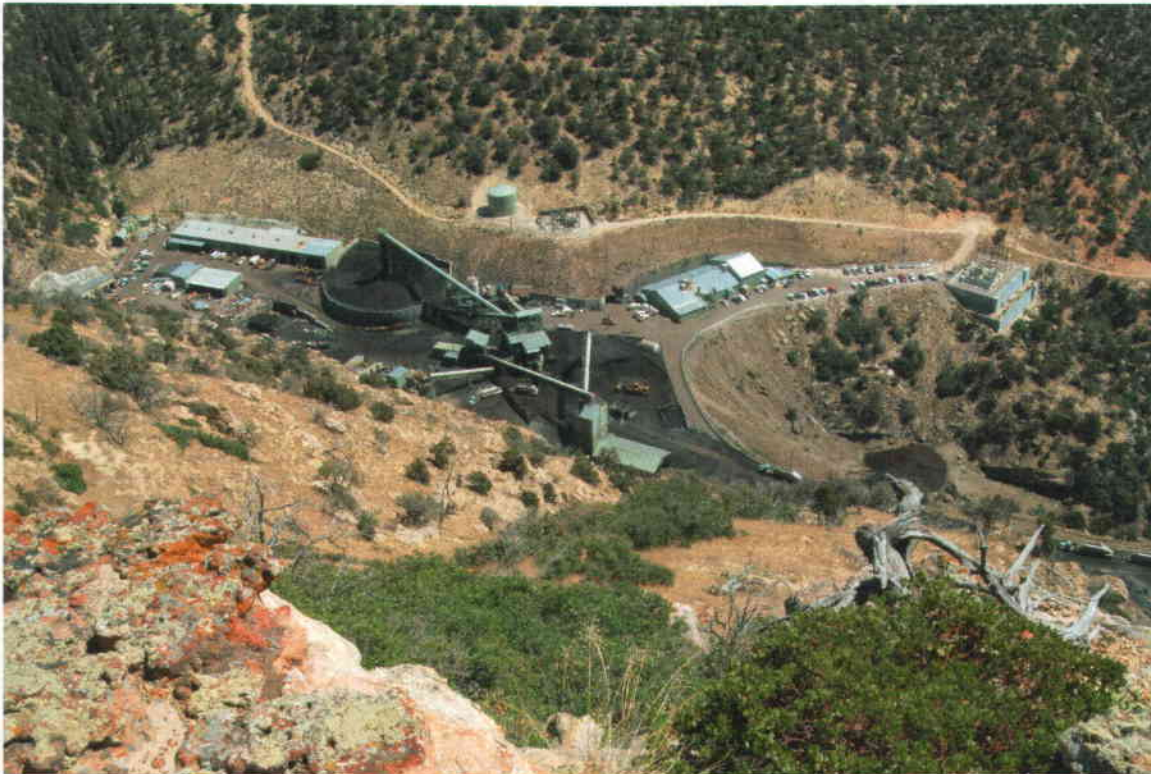


2008 ANNUAL REPORT



CANYON FUEL COMPANY, LLC SUFCO MINE ACT/041/002

File in:

☐ Confidential

☒ Shelf

☐ Expandable

Refer to Record No. 0014 Date 05/31/09

In C 0410002 2009 Incoming

For additional information Confidential!

2008 ANNUAL REPORT**Page 1**

This Annual Report shows information the Division has for your mine. Please review the information to see if it is current. If the information needs to be updated please do so in this document. At the end of each section the operator is asked to verify if the information is correct. Please answer these questions and make all comments on this document. Submit the completed document and any additional information identified in the Appendices to the Division by April 30, 2009. During a complete inspection an inspector will check and verify the information. To enter text, click in the cell and type your response. You can use the tab key to move from one field to the next. To enter an X in a box, click next to the box, right click, and select properties, then the checked circle, then hit enter, or hit the unchecked circle if the X is to be removed.

GENERAL INFORMATION

Permittee Name	Canyon Fuel Company, LLC
Mine Name	SUFCO Mine
Operator Name	
(If other then permittee)	
Permit Expiration Date	March 20, 2012
Permit Number	C/041/002
Authorized Representative Title	Kenneth E. May, General Manager
Phone Number	(435) 286-4880
Fax Number	(435) 286-4499
E-mail Address	kmay@archcoal.com and mdavis@archcoal.com
Mailing Address	597 South SR 24, Salina, UT 84654
Designated Representative	C.T. Corporation
Resident Agent	Corporation Trust Center
Resident Agent Mailing Address	1209 Orange Street, Wilmington, DE
Number of Binders Submitted	2

Operator, please update any incorrect information.

IDENTIFICATION OF OTHER PERMITS

Identify other permits that are required in conjunction with mining and reclamation activities.

Permit Type	ID Number	Description	Expiration Date
MSHA Mine ID(s)	4200089	Minesite	
	1211UT090008901	Waste Rock Disposal	
MSHA Impoundment(s)			
NPDES/UPDES Permit(s)	UT0022918	Minesite Sediment Pond Major Industrial	April 30, 2011
	UTR000576	Multi-Sector Storm Water Permit	December 31, 2011
PSD Permit(s) (Air)	DAQE-AN0665008-06	Minesite Air Quality Approval Order	
	BAQE-126-88	Waste Rock Disposal Air Quality Approval Order	
Other			

0014

C/041/002 Incoming
#3285



Canyon Fuel
Company, LLC.
Sufco Mine

A Subsidiary of Arch Western Bituminous Group, LLC.

COPY

Ken May, General Manager
597 South SR 24
Salina, UT 84654
(435) 286-4400 - Office
(435) 286-4499 - Fax

May 13, 2009

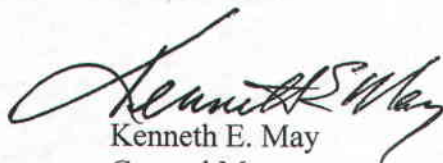
Utah Coal Regulatory Program
1594 West North Temple, Suite 1210
P. O. Box 145801
Salt Lake City, UT 84114-5801

Re: 2008 Annual Report for Canyon Fuel Company LLC, SUFCO Mine
C/041/002, Sevier County, Utah

Dear Permit Supervisor:

Enclosed herewith is a copy of the annual report for the Canyon Fuel Company, SUFCO Mine for 2008. The information included is thought to be complete as requested. Questions should be referred to Mike Davis at (435) 286-4421.

Sincerely,
CANYON FUEL COMPANY, LLC
SUFCO Mine


Kenneth E. May
General Manager

Enclosures

KEM/MLD:kb

cc: Division of Oil, Gas and Mining – Price Field Office
Division of Oil, Gas and Mining Correspondence File

SUFPUB\GOVT2009\DOGMCCORR\2008 Annual Report Cover ltr.doc

RECEIVED

MAY 18 2009

DIV. OF OIL, GAS & MINING

C/041/002 2009 Incoming
Refer to:
☒ Confidential
☐ Shelf
☐ Expandable
Date 05/30/09 For additional information

Operator, please update any incorrect information.

CERTIFIED REPORTS

Operator Comments:

Inspector:

Has the operator complied with this section? Yes ☐ No ☐

Inspector Comments:

Certified Reports:	Required		Included Included	or	DOGM file location Vol, Chapter, Page
	Yes	No			
Excess Spoil Piles	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
Refuse Piles	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		Certified reports previously submitted.
Impoundments	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		Certified reports previously submitted.
Other					
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		

Operator Comments:

Inspector:

Has the operator complied with this section? Yes ☐ No ☐

Inspector Comments:

COMMITMENTS AND CONDITIONS

The Permittee is responsible for ensuring annual technical commitments in the MRP and conditions accepted with the permit are completed throughout the year. The Division has identified these commitments below and has provided space for you to report what you have done during the past year for each commitment. If the particular section is blank, no commitment has been identified and no response is required for this report. If additional written response is required, it should be filed under Appendix B to this report.

Admin R645-301-100

Soils R645-301-200

Biology R645-301-300

Title: RAPTOR SURVEYS

Objective: To determine if there are nest sites or active nest sites and the number of juveniles present within ½ mile of surface mining activities or areas that may be impacted by subsidence.

Frequency: Annually.

Status: Ongoing.

Reports: Annual.

Citation: Volume 1, chapter 3, page 3-9.

Operator: Has this commitment been acted on this year?

Yes ☒ No ☐ Not required this year. ☐ If yes, comment;

Operator Comments: Raptor 2008 survey report is located in the Confidential folder.

Inspector:

Has the operator complied with this commitment? Yes ☐ No ☐

Inspector Comments:

Title: PRE SUBSIDENCE QUALITATIVE EVALUATION OF VEG AND CHANNEL CONDITIONS IN THE EAST FORK OF BOX CANYON.

Objective: To obtain data that characterizes the channel prior to subsidence.

Frequency: Fall of 2003 through 2005 then the Fall of 2008.

Status: During specified years.

Reports: 2003 and 2008 Annual reports.

Citation: Volume 1, chapter 3, page 3-22.

Operator: Has this commitment been acted on this year?

Yes ☒ No ☐ Not required this year. ☐ If yes, comment;

Operator Comments: Report is located in Appendix B.

Inspector:

Has the operator complied with this commitment? Yes ☐ No ☐

Inspector Comments:

Title: VEGETATIVE SURVEY OF THE EAST FORK OF BOX CANYON**Objective:** To determine if there are any impacts to the vegetative communities associated with the stream and canyon.**Frequency:** 2004, 05, 06, and 2008.**Status:** Ongoing.**Reports:** Annual.**Citation:** Volume 1, chapter 3, page 3-22A.**Operator:** Has this commitment been acted on this year?Yes ☒ No ☐ Not required this year. ☐ If yes, comment;**Operator Comments:** Report is located in Appendix B.**Inspector:**Has the operator complied with this commitment? Yes ☐ No ☐**Inspector Comments:****Title: COLOR INFRARED AERIAL PHOTOGRAPHY SURVEY****Objective:** To monitor potential changes in vegetative communities in areas that have subsided from longwall mining. The survey will include the upper portions of Box Canyon.**Frequency:** Once every 5 years beginning in 1987 (1990, 1995, 1999, 2003 (EF Box), 2004).**Status:** Next survey 2008.**Reports:** Annual**Operator:** Has this commitment been acted on this year?Yes ☒ No ☐ Not required this year. ☐ If yes, comment;**Operator Comments:** Color infrared aerial photography survey photos are located on CD at end of report.**Inspector:**Has the operator complied with this commitment? Yes ☐ No ☐**Inspector Comments:**

Title: PINES TRACT VEGETATION STUDY

Objective: To determine if longwall mining in the Pines Tract would potentially impact the Link Canyon Trail Columbine. The survey will include the portions of Box Canyon.

Frequency: Annually.

Status: Ongoing.

Reports: Annual.

Citation: Volume 1, chapter 3, page 3-45A.

Operator: Has this commitment been acted on this year?

Yes ☒ No ☐ Not required this year. ☐ If yes, comment;

Operator Comments: Report is located in Appendix B.

Inspector:

Has the operator complied with this commitment? Yes ☐ No ☐

Inspector Comments:

Title: LINK CANYON PORTAL VEGETATION STUDY

Objective: To determine if there are any impacts to the vegetation surrounding the portal area.

Frequency: Annually, June, September and November.

Status: Ongoing.

Reports: Annual.

Citation: Annual report.

Operator: Has this commitment been acted on this year?

Yes ☒ No ☐ Not required this year. ☐ If yes, comment;

Operator Comments: Report is located in Appendix B.

Inspector:

Has the operator complied with this commitment? Yes ☐ No ☐

Inspector Comments:

Title: CULTURAL RESOURCES

Objective: If during the course of mining operations, previously unidentified cultural resources are discovered, the Permittee shall ensure that the site(s) is not disturbed and shall notify the Division of Oil, Gas, and Mining. The Division, after coordination with OSM, shall inform the Permittee of necessary actions required. The Permittee shall implement the mitigation measures required by the Division within the time frame specified by the Division.

Frequency: As needed.

Status: Ongoing.

Reports: Annual.

Citation: Permit Condition Sec. 16.

Operator: Has this commitment been acted on this year?

Yes ☐ No ☐ Not required this year. ☒ If yes, comment;

Operator Comments: No previously unidentified cultural resources were discovered during the course of mining operations in 2008.

Inspector:

Has the operator complied with this commitment? Yes ☐ No ☐

Inspector Comments:

Engineering R645-301-500

Title: SUBSIDENCE MONITORING

Objective: Document the amount of subsidence that has occurred.

Frequency: Annual.

Status: On going.

Reports: Annual report.

Citation: p 5-29 .

Operator: Has this commitment been acted on this year?

Yes ☒ No ☐ Not required this year. ☐ If yes, comment;

Operator Comments: Report is located in Appendix B.

Inspector:

Has the operator complied with this commitment? Yes ☐ No ☐

Inspector Comments:

Title: MEASURE CRACKS.**Objective:** Measure cracks in the West Fork of Box Canyon.**Frequency:** Annually.**Status:** On going.**Reports:** Annual.**Citation:** P5-30.**Operator:** Has this commitment been acted on this year?Yes ☒ No ☐ Not required this year. ☐ If yes, comment;**Operator Comments:** The results are included in the 2008 subsidence report. These cracks are located in Longwall area 10 that has been mined out since 2001, and the area is now assumed to be dormant. This will be the last year these cracks will be monitored since there will not be any more movement in this area.**Inspector:**Has the operator complied with this commitment? Yes ☐ No ☐**Inspector Comments:**

Geology R645-301-600

Hydrology R645-301-700

Title: Climatological Data**Objective:** Collect climatological data to aid in determining effect of mining on runoff, stream flow, and local springs.**Frequency:** Annually.**Status:** Ongoing.**Reports:** Annual.**Citation:** Volume 2, P 7-51E.**Operator:** Has this commitment been acted on this year?Yes ☒ No ☐ Not required this year. ☐ If yes, comment;**Operator Comments:** Data is located in Appendix B.**Inspector:**Has the operator complied with this commitment? Yes ☐ No ☐**Inspector Comments:**

Bonding & Insurance R645-301-800

Other Commitments

*Reminder: If equipment has been abandoned during 2008, an amendment must be submitted that includes a map showing its location, a description of what was abandoned, whether there were any hazardous or toxic materials and any revision to the PHC as necessary.

REPORTING OF OTHER TECHNICAL DATA

List other technical data and information as required under the approved plan, which must be periodically submitted to the Division. Specify whether the information is included as Appendix B to this report or currently on file with the Division.

Operator Comments:

Inspector:

Has the operator complied with this section? Yes ☐ No ☐

Inspector Comments

LEGAL, FINANCIAL, COMPLIANCE AND RELATED INFORMATION

Change in administration or corporate structure can often bring about necessary changes to information found in the mining and reclamation plan. The Division is Requesting that each Permittee review and update the legal, financial, compliance and related information in the plan as part of the annual report. Please provide the Department of Commerce, Annual Report of Officers, or other equivalent information as necessary to ensure that the information provided in the plan is current. Provide any other change as necessary regarding land ownership, lease acquisitions, legal results from appeals of violations, or other changes as necessary to update information required in the mining and reclamation plan. Include certified financial statements, audits or worksheets, which may be required to meet bonding requirements. Specify whether the information is currently on file with the Division or included as Appendix C to the report.

Legal / Financial Update	Required Yes No	Included Included	or DOGM File location Vol, Chapter, Page
--------------------------	--------------------	----------------------	--

Department of Commerce, Annual Report Officers	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Submitted in Canyon Fuel General Chapter One
Other				
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Operator Comments:

Inspector:

Has the operator complied with this section? Yes ☐ No ☐

Inspector Comments:**MINE MAPS**

Copies of mine maps, current and up-to-date through at least December 31, 2008, are to be provided to the Division as Appendix D to this report in accordance with the requirements of R 645-301-525.240. The map copies shall be made in accordance with 30 CFR 75.1200 as required by MSHA. Mine maps are not considered confidential. (Please provide a CD.)

Confidential information is limited to:

R645-300-124.310. Information that pertains only to the analysis of the chemical and physical properties of the coal to be mined, except information on components of such coal which are potentially toxic in the environment.

R645-300-124.330. Information on the nature and location of archeological resources on public land and Indian land as required under the Archeological Resources Protection Act of 1979 (P. L. 96-95, 93 Stat. 721, 16 U.S.C. 470).

R645-301-322, Fish and Wildlife Information; R645-301-322.100, the scope and level of detail for such information will be determined by the Division in consultation with state and federal agencies with responsibilities for fish and wildlife and will be sufficient to design the protection and enhancement plan required under R645-301-333 and R645-301-322.230, other species or habitats identified through agency consultation as requiring special protection under state or federal law; R645-301-333.300, Include protective measures that will be used during the active mining phase of operation.

The Division will provide procedures, including notice and opportunity to be heard for persons both seeking and opposing disclosure.

Map Number(s)**Map Title/ Description**

Annual subsidence map	Mine Subsidence Map		
Mine map	Mining Progress 2008		
Other maps		Confidential	
		Yes	No
		<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>

Operator Comments:**Inspector:**

Has the operator complied with this section? Yes ☐ No ☐

Inspector Comments:

OTHER INFORMATION

Please provide any comments of further information to be included as part of the Annual Report. Any other attachments are to be provided as Appendix E to this report. If information is submitted as a group rather than by individual mine, please identify each of the mine's data in the list below.

Additional attachment to this report?

Yes ☐

No ☒

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. On the left edge, there is a circular punch hole, suggesting it's part of a notebook or binder. The paper is otherwise blank, with no writing or markings.

Operator Comments:

Inspector:

Has the operator complied with this section? Yes ☐ No ☐

Inspector Comments

APPENDIX A

Certified Reports

Excess Spoil Piles
Refuse Piles
Impoundments

As required under R645-301-514

CONTENTS

None - Certified Reports previously submitted.

APPENDIX B

Reporting of Technical Data

Including monitoring data, reports, maps, and other information
As required under the approved plan or as required by the Division

In accordance with the requirement of R645-310-130 and R645-301-140

CONTENTS

Climatological Data
Comparison of Weather Data and Stream Discharge
Subsidence Report
Vegetation Monitoring-Pines Tract
Vegetation Monitoring - Link Canyon Portals
Soils Monitoring - Waste Rock Disposal Site
East Fork of Box Canyon Studies-Biomonitoring
East Fork of Box Canyon Studies-Hydrology

CMK:KB

-----SUF-----

--Temp-- ----Pptn----

Max Min Moist. SnowDD/MM/YY**2008**

1-Jan-08	16	-4		
2-Jan-08	19	4		
3-Jan-08	21	12		
4-Jan-08	27	16		
5-Jan-08	36	23		
6-Jan-08	31	20	0.34	5
7-Jan-08	28	7		
8-Jan-08	22	6	0.34	5
9-Jan-08	25	18		
10-Jan-08	32	15		
11-Jan-08	31	21		
12-Jan-08	30	16		
13-Jan-08	27	19		
14-Jan-08	34	9		
15-Jan-08	36	16		
16-Jan-08	20	9		
17-Jan-08	11	-8		
18-Jan-08	22	6	0.01	1
19-Jan-08	25	13		
20-Jan-08	20	2		
21-Jan-08	26	10	0.02	1
22-Jan-08	26	9		
23-Jan-08	24	4		
24-Jan-08	23	11		
25-Jan-08	23	6	0.03	1
26-Jan-08	24	8		
27-Jan-08	22	10	0.02	1
28-Jan-08	31	12	0.06	1
29-Jan-08	18	6	0.22	2.5
30-Jan-08	17	10	0.49	9
31-Jan-08	18	3	0.05	1
1-Feb-08	22	11	0.03	1
2-Feb-08	22	12	0.35	5
3-Feb-08	25	6	0.45	8
4-Feb-08	25	14	0.01	0.2
5-Feb-08	17	8		
6-Feb-08	24	10	0.04	0.5
7-Feb-08	36	15	0.02	0.2
8-Feb-08	37	19	0.05	0.5
9-Feb-08	40	25		
10-Feb-08	37	17		
11-Feb-08	36	23		
12-Feb-08	35	26		
13-Feb-08	35	18		

CMK:KB

-----SUFCO-----

--Temp--

----Pptn----

<u>DD/MM/YY</u>	<u>Max</u>	<u>Min</u>	<u>Moist</u>	<u>Snow</u>
14-Feb-08	38	12	0.07	2.5
15-Feb-08	29	-2	0.01	0.2
16-Feb-08	37	13		
17-Feb-08	29	20		
18-Feb-08	41	20		
19-Feb-08	38	14		
20-Feb-08	31	20		
21-Feb-08	34	18	0.03	0.2
22-Feb-08	32	23	0.07	1.5
23-Feb-08	35	22	0.32	6
24-Feb-08	41	24		
25-Feb-08	35	25	0.10	2
26-Feb-08	41	23		
27-Feb-08	41	21		
28-Feb-08	47	28		
29-Feb-08	47	23		
1-Mar-08	51	26		
2-Mar-08	51	14		
3-Mar-08	36	7		
4-Mar-08	34	21		
5-Mar-08	28	9	0.01	0.1
6-Mar-08	29	16	0.01	0.1
7-Mar-08	44	21		
8-Mar-08	42	25		
9-Mar-08	40	23		
10-Mar-08	44	19		
11-Mar-08	48	23		
12-Mar-08	47	25		
13-Mar-08	47	24		
14-Mar-08	44	24	0.05	0.5
15-Mar-08	32	15		
16-Mar-08	26	13	0.30	3
17-Mar-08	32	15		
18-Mar-08	39	22		
19-Mar-08	49	22		
20-Mar-08	48	28		
21-Mar-08	42	31		
22-Mar-08	42	19		
23-Mar-08	48	16		
24-Mar-08	57	25		
25-Mar-08	56	39		
26-Mar-08	58	37		
27-Mar-08	53	30		
28-Mar-08	43	20		
29-Mar-08	50	30		

CMK:KB

-----SUFCO-----

--Temp--

----Pptn----

DD/MM/YYMaxMinMoist.Snow

30-Mar-08	47	31		
31-Mar-08	34	18	0.20	3.5
1-Apr-08	40	9		
2-Apr-08	48	24		
3-Apr-08	44	29		
4-Apr-08	48	18		
5-Apr-08	49	35		
6-Apr-08	48	24		
7-Apr-08	46	25	0.10	1
8-Apr-08	43	18		
9-Apr-08	41	27	0.02	0.2
10-Apr-08	31	19	0.05	0.5
11-Apr-08	35	21		
12-Apr-08	47	20		
13-Apr-08	57	27		
14-Apr-08	65	32		
15-Apr-08	64	41		
16-Apr-08	43	19		
17-Apr-08	41	15	0.01	0.1
18-Apr-08	57	27		
19-Apr-08	58	31		
20-Apr-08	57	36		
21-Apr-08	45	17		
22-Apr-08	57	26		
23-Apr-08	56	34		
24-Apr-08	52	28		
25-Apr-08	48	18		
26-Apr-08	46	31		
27-Apr-08	55	20		
28-Apr-08	64	31		
29-Apr-08	65	39		
30-Apr-08	66	33		
1-May-08	35	18	0.13	1.5
2-May-08	46	23		
3-May-08	51	23		
4-May-08	57	32		
5-May-08	63	36		
6-May-08	64	36		
7-May-08	62	38		
8-May-08	55	35		
9-May-08	55	31		
10-May-08	54	32		
11-May-08	66	31		
12-May-08	66	32		
13-May-08	46	21		

CMK:KB

-----SUFCO-----

--Temp-- ----Pptn----

<u>DD/MM/YY</u>	<u>Max</u>	<u>Min</u>	<u>Moist.</u>	<u>Snow</u>
14-May-08	50	34		
15-May-08	55	42		
16-May-08	65	33		
17-May-08	72	40		
18-May-08	73	43		
19-May-08	76	50		
20-May-08	80	49		
21-May-08	79	33		
22-May-08	42	28	0.04	
23-May-08	40	30	0.48	5
24-May-08	45	26	0.03	
25-May-08	52	32		
26-May-08	52	36		
27-May-08	59	31		
28-May-08	63	37		
29-May-08	62	36		
30-May-08	65	35		
31-May-08	70	38		
1-Jun-08	76	41		
2-Jun-08	76	42		
3-Jun-08	69	49		
4-Jun-08	67	37		
5-Jun-08	44	34	0.37	
6-Jun-08	71	34		
7-Jun-08	71	35		
8-Jun-08	55	31		
9-Jun-08	73	31		
10-Jun-08	77	42		
11-Jun-08	73	37		
12-Jun-08	57	31		
13-Jun-08	71	33		
14-Jun-08	77	41		
15-Jun-08	81	50		
16-Jun-08	82	51		
17-Jun-08	83	51		
18-Jun-08	81	54		
19-Jun-08	75	47		
20-Jun-08	80	44		
21-Jun-08	79	49		
22-Jun-08	81	53		
23-Jun-08	79	52		
24-Jun-08	82	49		
25-Jun-08	82	51		
26-Jun-08	80	54		
27-Jun-08	79	55		

CMK:KB

-----SUFCO-----

--Temp-- ----Pptn----

<u>DD/MM/YY</u>	<u>Max</u>	<u>Min</u>	<u>Moist.</u>	<u>Snow</u>
28-Jun-08	81	51		
29-Jun-08	82	52		
30-Jun-08	80	52		
1-Jul-08	82	55		
2-Jul-08	82	50		
3-Jul-08	83	53		
4-Jul-08	84	58		
5-Jul-08	81	60		
6-Jul-08	79	49		
7-Jul-08	77	46		
8-Jul-08	81	49		
9-Jul-08	83	49		
10-Jul-08	86	51		
11-Jul-08	83	54		
12-Jul-08	81	50		
13-Jul-08	81	53		
14-Jul-08	80	55		
15-Jul-08	83	60		
16-Jul-08	82	60	0.02	
17-Jul-08	80	49		
18-Jul-08	83	57		
19-Jul-08	85	55		
20-Jul-08	81	59		
21-Jul-08	78	56	0.08	
22-Jul-08	75	56		
23-Jul-08	84	54		
24-Jul-08	87	54		
25-Jul-08	86	56		
26-Jul-08	79	54		
27-Jul-08	79	55		
28-Jul-08	80	50		
29-Jul-08	85	55		
30-Jul-08	85	55		
31-Jul-08	86	59		
1-Aug-08	86	65		
2-Aug-08	84	61		
3-Aug-08	83	59		
4-Aug-08	83	60		
5-Aug-08	79	54	0.40	
6-Aug-08	79	54		
7-Aug-08	68	56	0.30	
8-Aug-08	73	52	0.04	
9-Aug-08	73	52		
10-Aug-08	81	50	0.10	
11-Aug-08	81	51		

CMK:KB

-----SUFCO-----

--Temp--

----Pptn----

<u>DD/MM/YY</u>	<u>Max</u>	<u>Min</u>	<u>Moist.</u>	<u>Snow</u>
12-Aug-08	81	51		
13-Aug-08	82	56		
14-Aug-08	82	51		
15-Aug-08	79	51		
16-Aug-08	74	39		
17-Aug-08	77	43		
18-Aug-08	81	49		
19-Aug-08	83	57		
20-Aug-08	82	61		
21-Aug-08	84	56		
22-Aug-08	83	59		
23-Aug-08	85	53		
24-Aug-08	82	54		
25-Aug-08	76	52		
26-Aug-08	79	50		
27-Aug-08	78	51		
28-Aug-08	79	52		
29-Aug-08	82	44		
30-Aug-08	81	52		
31-Aug-08	77	52		
1-Sep-08	63	48	0.05	
2-Sep-08	63	28		
3-Sep-08	66	38		
4-Sep-08	72	42		
5-Sep-08	69	39		
6-Sep-08	70	43		
7-Sep-08	76	44		
8-Sep-08	74	46		
9-Sep-08	71	49		
10-Sep-08	68	41	0.05	
11-Sep-08	66	41	0.20	
12-Sep-08	63	34	0.02	
13-Sep-08	69	38		
14-Sep-08	72	38		
15-Sep-08	73	41		
16-Sep-08	72	44		
17-Sep-08	70	45		
18-Sep-08	70	44		
19-Sep-08	70	43		
20-Sep-08	69	46		
21-Sep-08	70	42		
22-Sep-08	69	46		
23-Sep-08	64	34		
24-Sep-08	69	39		
25-Sep-08	75	45		

CMK:KB

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--Temp-- ----Pptn----

<u>DD/MM/YY</u>	<u>Max</u>	<u>Min</u>	<u>Moist.</u>	<u>Snow</u>
26-Sep-08	74	49		
27-Sep-08	73	47		
28-Sep-08	70	44		
29-Sep-08	70	45		
30-Sep-08	71	46		
1-Oct-08	72	44		
2-Oct-08	69	44		
3-Oct-08	66	49		
4-Oct-08	60	40	0.10	
5-Oct-08	48	37	0.48	
6-Oct-08	56	31		
7-Oct-08	60	33		
8-Oct-08	63	37		
9-Oct-08	66	36		
10-Oct-08	64	28		
11-Oct-08	51	27		
12-Oct-08	32	17	0.20	2
13-Oct-08	37	14		
14-Oct-08	47	18		
15-Oct-08	55	29		
16-Oct-08	62	33		
17-Oct-08	63	36		
18-Oct-08	61	36		
19-Oct-08	60	38		
20-Oct-08	58	38	0.04	
21-Oct-08	52	34		
22-Oct-08	45	18		
23-Oct-08	55	30		
24-Oct-08	54	32		
25-Oct-08	61	38		
26-Oct-08	60	36		
27-Oct-08	60	35		
28-Oct-08	61	37		
29-Oct-08	68	38		
30-Oct-08	63	37		
31-Oct-08	59	39		
1-Nov-08	58	40		
2-Nov-08	55	35	0.06	
3-Nov-08	44	25	0.46	
4-Nov-08	27	20		
5-Nov-08	31	15	0.06	
6-Nov-08	45	25	0.01	
7-Nov-08	47	28		
8-Nov-08	44	30		
9-Nov-08	37	24		

CMK:KB

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--Temp--

----Pptn----

<u>DD/MM/YY</u>	<u>Max</u>	<u>Min</u>	<u>Moist.</u>	<u>Snow</u>
10-Nov-08	34	28		
11-Nov-08	36	28		
12-Nov-08	38	31		
13-Nov-08	50	37		
14-Nov-08	47	33		
15-Nov-08	48	28		
16-Nov-08	57	29		
17-Nov-08	56	33		
18-Nov-08	53	34		
19-Nov-08	51	31		
20-Nov-08	48	29		
21-Nov-08	46	26		
22-Nov-08	43	23		
23-Nov-08	47	24		
24-Nov-08	41	22		
25-Nov-08	41	24		
26-Nov-08	28	24		
27-Nov-08	36	28		
28-Nov-08	35	32	0.05	
29-Nov-08	35	29		
30-Nov-08	38	32		
1-Dec-08	55	35		
2-Dec-08	53	39		
3-Dec-08	57	26		
4-Dec-08	34	20		
5-Dec-08	35	18		
6-Dec-08	45	28		
7-Dec-08	39	27		
8-Dec-08	36	25		
9-Dec-08	28	14	0.02	0.5
10-Dec-08	43	19		
11-Dec-08	46	26		
12-Dec-08	40	22		
13-Dec-08	39	20		
14-Dec-08	20	8	0.03	0.7
15-Dec-08	14	-2		
16-Dec-08	23	8	0.13	3
17-Dec-08	24	2		
18-Dec-08	28	15	0.08	1
19-Dec-08	32	8		
20-Dec-08	27	13		
21-Dec-08	22	10		
22-Dec-08	28	13		
23-Dec-08	25	7	0.30	5
24-Dec-08	16	1		

CMK:KB

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--Temp-- ----Pptn----

<u>DD/MM/YY</u>	<u>Max</u>	<u>Min</u>	<u>Moist</u>	<u>Snow</u>
25-Dec-08	22	12	0.04	1
26-Dec-08	25	8	0.26	6
27-Dec-08	19	4		
28-Dec-08	26	8		
29-Dec-08	30	9		
30-Dec-08	33	11		
31-Dec-08	34	15		
			<u>8.51</u>	

Sufco East Fork Box Canyon Weather Station
Weather Data, 2004-2008

PETERSEN HYDROLOGIC, LLC

	Daily Precip. (inches)	Daily Max Temp. (°F)	Daily Min Temp. (°F)
August 2004			
8/23/2004	0.03	69.3	37.0
8/24/2004	0.00	64.8	38.3
8/25/2004	0.00	68.8	38.6
8/26/2004	0.00	75.7	40.4
8/27/2004	0.00	70.3	43.5
8/28/2004	0.00	68.0	27.5
8/29/2004	0.00	74.5	22.4
8/30/2004	0.00	77.9	30.0
8/31/2004	0.00	75.1	30.6
August 2004 summary (partial)	0.03	77.9	22.4
September 2004			
9/1/2004	0.00	78.1	33.7
9/2/2004	0.00	79.9	33.0
9/3/2004	0.00	80.6	37.6
9/4/2004	0.04	67.5	38.7
9/5/2004	0.01	56.5	29.8
9/6/2004	0.00	68.4	25.0
9/7/2004	0.00	73.6	25.8
9/8/2004	0.00	76.2	29.0
9/9/2004	0.00	76.9	30.8
9/10/2004	0.00	74.7	34.0
9/11/2004	0.00	75.3	33.2
9/12/2004	0.00	78.0	32.5
9/13/2004	0.00	72.0	39.5
9/14/2004	0.00	75.6	39.5
9/15/2004	0.00	62.9	34.3
9/16/2004	0.00	69.1	19.9
9/17/2004	0.00	74.2	27.7
9/18/2004	0.00	78.8	31.5
9/19/2004	0.00	69.0	30.5
9/20/2004	0.17	56.3	41.8
9/21/2004	0.00	49.9	25.0
9/22/2004	0.01	46.7	23.8
9/23/2004	0.00	53.3	17.4
9/24/2004	0.00	62.9	20.4
9/25/2004	0.00	64.0	24.5
9/26/2004	0.00	68.1	24.1

9/27/2004	0.00	69.8	24.9
9/28/2004	0.00	68.2	26.3
9/29/2004	0.00	65.1	28.3
9/30/2004	0.31	48.5	34.9
September 2004 summary	0.54	80.6	17.4

October 2004

10/1/2004	0.17	50.7	30.2
10/2/2004	0.22	53.7	27.3
10/3/2004	0.28	52.1	30.5
10/4/2004	0.00	59.7	28.3
10/5/2004	0.00	61.1	27.0
10/6/2004	0.12	55.8	34.1
10/7/2004	0.00	58.1	27.2
10/8/2004	0.00	64.9	24.3
10/9/2004	0.00	66.2	25.4
10/10/2004	0.00	64.4	24.4
10/11/2004	0.02	54.2	30.9
10/12/2004	0.00	57.3	28.0
10/13/2004	0.00	62.4	24.8
10/14/2004	0.00	56.2	28.1
10/15/2004	0.00	66.4	27.8
10/16/2004	0.00	62.5	28.3
10/17/2004	0.00	66.2	27.4
10/18/2004	0.12	48.8	25.4
10/19/2004	0.02	46.8	28.2
10/20/2004	0.13	42.0	34.5
10/21/2004	0.30	41.9	36.8
10/22/2004	0.43	37.7	31.9
10/23/2004	0.13	32.3	16.0
10/24/2004	0.51	42.4	12.2
10/25/2004	0.05	43.2	27.6
10/26/2004	0.15	43.4	26.8
10/28/2004	0.23	41.1	31.5
10/29/2004	0.18	34.0	25.0
10/30/2004	0.00	34.3	19.6
10/31/2004	0.00	43.2	18.6
October 2004 summary	3.06	66.4	12.2

November 2004

11/1/2004	0.05	30.1	16.2
11/2/2004	0.01	31.0	10.2
November 2004 summary (partial)	0.06	31.0	10.2

May 2005

5/17/2005	0.07	51.5	29.3
5/18/2005	0.00	67.9	31.0
5/19/2005	0.00	76.5	34.8
5/20/2005	0.00	80.2	33.4
5/21/2005	0.00	75.2	45.5
5/22/2005	0.00	76.5	35.3
5/23/2005	0.00	76.8	35.8
5/24/2005	0.00	74.6	36.1
5/25/2005	0.00	72.0	35.8
5/26/2005	0.00	70.4	29.9
5/27/2005	0.00	70.7	32.3
5/28/2005	0.00	69.5	35.5
5/29/2005	0.00	73.8	35.3
5/30/2005	0.00	50.7	30.2
5/31/2005	0.00	63.4	27.5
May 2005 summary (partial)	0.07	80.2	27.5

June 2005

6/1/2005	0.00	66.0	32.6
6/2/2005	1.25	52.1	37.3
6/3/2005	1.43	43.6	32.0
6/4/2005	0.00	59.4	29.5
6/5/2005	0.00	64.8	29.6
6/6/2005	0.00	62.5	34.3
6/7/2005	0.00	55.2	30.0
6/8/2005	0.00	61.2	24.8
6/9/2005	0.00	53.8	32.2
6/10/2005	0.00	58.1	28.5
6/11/2005	0.47	48.5	32.7
6/12/2005	0.01	55.0	36.8
6/13/2005	0.00	63.3	31.7
6/14/2005	0.00	69.6	29.1
6/15/2005	0.27	70.3	39.4
6/16/2005	0.00	74.6	35.3
6/17/2005	0.00	76.2	32.6
6/18/2005	0.00	76.3	35.4
6/19/2005	0.00	78.9	34.9
6/20/2005	0.00	78.8	36.4
6/21/2005	0.00	79.0	40.0
6/22/2005	0.19	71.1	44.5
6/23/2005	0.00	69.9	40.6
6/24/2005	0.11	71.5	34.3
6/25/2005	0.03	66.9	36.3
6/26/2005	0.00	73.1	32.1
6/27/2005	0.00	77.4	29.2
6/28/2005	0.02	65.4	39.7
6/29/2005	0.00	70.4	34.2
6/30/2005	0.00	76.6	31.8
June 2005 summary	3.78	79.0	24.8

July 2005

7/1/2005	0.00	79.6	35.2
7/2/2005	0.00	81.9	36.0
7/3/2005	0.00	76.8	38.2
7/4/2005	0.00	81.1	32.1
7/5/2005	0.00	82.3	35.9
7/6/2005	0.00	82.8	35.4
7/7/2005	0.00	83.8	35.6
7/8/2005	0.00	84.3	33.4
7/9/2005	0.00	80.1	34.6
7/10/2005	0.00	83.5	38.7
7/11/2005	0.00	83.2	39.3
7/12/2005	0.00	89.0	41.4
7/13/2005	0.00	87.6	42.4
7/14/2005	0.00	87.0	42.5
7/15/2005	0.00	85.1	42.9
7/16/2005	0.00	87.7	48.4
7/17/2005	0.00	83.2	45.9
7/18/2005	0.00	82.9	37.4
7/19/2005	0.00	88.5	39.6
7/20/2005	0.00	90.3	46.5
7/21/2005	0.00	89.3	47.2
7/22/2005	0.03	85.5	50.6
7/23/2005	0.04	76.8	48.4
7/24/2005	0.03	74.3	41.9
7/25/2005	0.10	77.6	41.0
7/26/2005	0.00	75.9	36.4
7/27/2005	0.00	79.9	26.5
7/28/2005	0.00	86.0	33.7
7/29/2005	0.00	77.6	40.5
7/30/2005	0.05	75.6	47.1
7/31/2005	0.00	77.3	48.0
July 2005 summary	0.25	90.3	26.5

August 2005

8/1/2005	0.03	66.7	47.1
8/2/2005	0.40	70.4	41.4
8/3/2005	0.24	69.8	39.5
8/4/2005	0.00	73.4	39.8
8/5/2005	0.43	70.6	40.4
8/6/2005	0.00	70.5	40.0
8/7/2005	0.00	77.4	41.9
8/8/2005	0.24	76.3	43.6
8/9/2005	0.06	73.2	45.9
8/10/2005	0.32	66.6	50.4
8/11/2005	0.03	72.5	48.3
8/12/2005	0.00	73.9	40.2
8/13/2005	0.00	75.3	43.4
8/14/2005	0.08	70.2	38.6

8/15/2005	0.01	72.1	37.8
8/16/2005	0.01	71.5	43.5
8/17/2005	0.00	73.1	38.5
8/18/2005	0.00	72.9	35.8
8/19/2005	0.00	72.1	36.2
8/20/2005	0.00	71.9	35.8
8/21/2005	0.00	72.5	36.1
8/22/2005	0.01	72.9	37.2
8/23/2005	0.07	70.1	39.5
8/24/2005	0.02	74.7	36.2
8/25/2005	0.00	76.2	38.5
8/26/2005	0.00	80.4	38.5
8/27/2005	0.13	75.2	37.6
8/28/2005	0.00	76.4	34.3
8/29/2005	0.00	82.0	33.5
8/30/2005	0.00	69.4	33.8
8/31/2005	0.00	77.2	21.0
August 2005 summary	2.08	82.0	21.0

September 2005

9/1/2005	0.00	77.3	26.1
9/2/2005	0.00	76.6	32.4
9/3/2005	0.12	70.7	36.3
9/4/2005	0.06	68.7	33.1
9/5/2005	0.01	76.0	32.6
9/6/2005	0.00	73.4	35.3
9/7/2005	0.00	73.9	36.3
9/8/2005	0.00	69.1	39.3
9/9/2005	0.18	63.7	41.2
9/10/2005	0.00	68.7	27.7
9/11/2005	0.00	72.0	31.1
9/12/2005	0.00	63.6	33.1
9/13/2005	0.00	62.8	21.6
9/14/2005	0.00	62.9	25.5
9/15/2005	0.00	68.8	19.2
9/16/2005	0.00	66.8	24.2
9/17/2005	0.00	70.6	24.2
9/18/2005	0.00	67.9	27.0
9/19/2005	0.00	73.2	23.4
9/20/2005	0.00	74.7	27.9
9/21/2005	0.16	60.5	35.0
9/22/2005	0.01	65.1	28.1
9/23/2005	0.00	65.8	29.9
9/24/2005	0.00	67.7	31.5
9/25/2005	0.00	67.0	26.2
9/26/2005	0.00	70.9	23.5
9/27/2005	0.23	61.4	36.1
9/28/2005	0.54	54.0	34.3
9/29/2005	0.00	66.0	29.5
9/30/2005	0.00	70.9	23.2

September 2005 summary**1.31****77.3****19.2****October 2005**

10/1/2005	0.00	68.7	24.6
10/2/2005	0.00	70.2	30.4
10/3/2005	0.00	69.4	43.5
10/4/2005	0.05	47.3	22.9
10/5/2005	0.00	45.2	12.7
10/6/2005	0.00	57.6	12.9
10/7/2005	0.00	61.7	16.7
10/8/2005	0.00	56.6	23.3
10/9/2005	0.00	46.8	25.0
10/10/2005	0.00	49.9	23.5
10/11/2005	0.00	58.3	17.5
10/12/2005	0.00	56.1	20.7
10/13/2005	0.00	62.3	17.7
10/14/2005	0.00	64.0	19.2
10/15/2005	0.00	59.5	19.8
10/16/2005	0.05	57.5	27.7
10/17/2005	0.00	61.2	23.1
10/18/2005	0.74	47.8	28.5
10/19/2005	0.01	50.1	28.4
10/20/2005	0.01	56.9	25.3
10/21/2005	0.00	59.2	23.1
10/22/2005	0.00	59.6	22.8
10/23/2005	0.00	57.9	24.1
10/24/2005	0.00	62.0	23.6
10/25/2005	0.00	57.6	24.6
10/26/2005	0.00	57.0	21.9
October 2005 summary (partial)	0.86	70.2	12.7

April 2006

4/27/2006	0.00	65.3	33.7
4/28/2006	0.00	58.0	25.7
4/29/2006	0.00	58.9	18.9
4/30/2006	0.00	58.1	29.0
April 2006 summary (partial)	0.00	65.3	18.9

May 2006

5/1/2006	0.00	62.8	20.7
5/2/2006	0.00	63.9	26.5
5/3/2006	0.00	62.5	31.9
5/4/2006	0.09	55.9	30.6
5/5/2006	0.02	53.3	26.2
5/6/2006	0.00	55.0	22.0
5/7/2006	0.00	58.6	24.9
5/8/2006	0.00	58.1	31.8
5/9/2006	0.00	53.2	26.0

5/10/2006	0.00	56.6	21.3
5/12/2006	0.00	72.0	25.0
5/13/2006	0.00	69.7	29.9
5/14/2006	0.00	69.6	33.4
5/15/2006	0.00	70.4	33.3
5/16/2006	0.00	73.2	27.7
5/17/2006	0.00	75.5	28.9
5/18/2006	0.00	75.6	30.1
5/19/2006	0.21	72.4	38.6
5/20/2006	0.00	73.5	33.2
5/21/2006	0.00	74.2	33.1
5/22/2006	0.00	64.0	40.9
5/23/2006	0.00	65.6	33.9
5/24/2006	0.00	75.0	27.5
5/25/2006	0.00	77.0	28.7
5/26/2006	0.00	78.3	35.1
5/27/2006	0.00	62.7	31.8
5/28/2006	0.02	40.6	20.9
5/29/2006	0.00	56.7	11.9
5/30/2006	0.00	62.7	15.0
5/31/2006	0.00	70.3	23.1
May 2006 Summary	0.34	78.3	11.9

June 2006

6/1/2006	0.00	78.3	25.5
6/2/2006	0.00	79.1	28.6
6/3/2006	0.00	77.2	37.8
6/4/2006	0.00	81.4	33.1
6/5/2006	0.00	82.1	40.6
6/6/2006	0.00	87.1	36.4
6/7/2006	0.00	79.9	41.8
6/8/2006	0.41	64.4	38.8
6/9/2006	0.04	67.5	34.2
6/10/2006	0.00	75.1	33.4
6/11/2006	0.00	79.3	29.9
6/12/2006	0.00	79.1	29.6
6/13/2006	0.00	74.4	25.7
6/14/2006	0.00	63.5	41.9
6/15/2006	0.00	56.9	38.7
6/16/2006	0.00	63.1	37.3
6/17/2006	0.00	76.6	27.8
6/18/2006	0.00	81.5	31.0
6/19/2006	0.00	82.9	32.7
6/20/2006	0.00	77.8	38.7
6/21/2006	0.00	79.5	33.2
6/22/2006	0.00	78.1	34.2
6/23/2006	0.00	84.0	31.7
6/24/2006	0.00	84.1	31.6
6/25/2006	0.00	80.7	31.0
6/26/2006	0.00	76.0	35.3

6/27/2006	0.00	79.6	32.1
6/28/2006	0.17	74.3	39.7
6/29/2006	0.00	76.5	39.9
6/30/2006	0.11	75.6	38.7
June 2006 Summary	0.73	87.1	25.5

July 2006

7/1/2006	0.10	72.8	41.9
7/2/2006	0.04	75.5	46.0
7/3/2006	0.00	77.9	44.1
7/4/2006	0.11	75.9	48.8
7/5/2006	0.02	71.8	44.8
7/6/2006	0.07	71.9	50.1
7/7/2006	0.32	68.9	41.5
7/8/2006	0.00	65.4	44.5
7/9/2006	0.00	76.9	44.6
7/10/2006	0.22	70.5	40.5
7/11/2006	0.04	73.6	40.5
7/12/2006	0.01	80.7	40.1
7/13/2006	0.00	83.3	40.8
7/14/2006	0.00	87.5	38.1
7/15/2006	0.00	89.5	40.8
7/16/2006	0.00	87.7	46.7
7/17/2006	0.00	86.0	50.0
7/18/2006	0.00	84.3	45.3
7/19/2006	1.22	80.5	47.1
7/20/2006	0.06	78.5	44.9
7/21/2006	0.00	84.4	48.2
7/22/2006	0.00	84.7	51.5
7/23/2006	0.00	85.8	46.4
7/24/2006	0.07	85.9	49.9
7/25/2006	0.17	75.8	54.3
7/26/2006	0.00	82.7	47.4
7/27/2006	0.00	82.7	44.5
7/28/2006	0.00	84.6	43.5
7/29/2006	0.00	85.5	49.1
7/30/2006	0.41	73.7	57.1
7/31/2006	0.38	73.4	49.3
July 2006 Summary	3.24	89.5	38.1

August 2006

8/1/2006	0.01	67.3	42.6
8/2/2006	0.00	68.7	40.6
8/3/2006	0.13	66.0	46.2
8/4/2006	0.05	63.5	43.6
8/5/2006	0.00	69.5	40.5
8/6/2006	0.00	75.8	40.5
8/7/2006	0.33	73.2	42.1
8/8/2006	0.00	77.8	42.4

8/9/2006	0.00	76.8	43.1
8/10/2006	0.01	77.3	39.1
8/11/2006	0.04	76.3	42.4
8/12/2006	0.00	75.2	43.5
8/13/2006	0.00	73.4	40.1
8/14/2006	0.00	76.6	38.6
8/15/2006	0.14	72.8	42.6
8/16/2006	0.09	69.3	38.6
8/17/2006	0.00	76.9	39.5
8/18/2006	0.00	77.5	37.4
8/19/2006	0.00	79.8	36.0
8/20/2006	0.00	75.9	39.9
8/21/2006	0.00	78.0	41.2
8/22/2006	0.00	79.4	45.8
8/23/2006	0.06	76.5	39.3
8/24/2006	0.12	75.6	41.9
8/25/2006	0.38	71.0	39.0
8/26/2006	0.00	68.2	36.9
8/27/2006	0.00	70.2	31.8
8/28/2006	0.00	74.2	32.4
8/29/2006	0.00	79.4	32.6
8/30/2006	0.00	79.3	34.1
8/31/2006	0.00	77.3	40.8
August 2006 Summary	1.36	79.8	31.8

September 2006

9/1/2006	0.00	75.9	33.7
9/2/2006	0.00	76.5	33.6
9/3/2006	0.00	77.5	31.4
9/4/2006	0.00	75.6	34.7
9/5/2006	0.03	74.0	35.1
9/6/2006	0.14	71.9	43.1
9/7/2006	0.01	63.8	37.1
9/8/2006	0.00	61.9	40.1
9/9/2006	0.19	66.3	34.2
9/10/2006	0.03	64.2	33.8
9/11/2006	0.00	69.8	29.8
9/12/2006	0.00	73.6	32.0
9/13/2006	0.00	75.3	30.8
9/14/2006	0.52	64.6	33.1
9/15/2006	0.19	57.8	33.8
9/16/2006	0.03	42.3	23.2
9/17/2006	0.00	48.1	21.4
9/18/2006	0.00	59.2	18.4
9/19/2006	0.00	63.2	20.6
9/20/2006	0.06	44.8	31.3
9/21/2006	0.04	47.4	31.3
9/22/2006	0.10	38.5	26.4
9/23/2006	0.00	46.7	16.9
9/24/2006	0.00	55.9	19.2

9/25/2006	0.00	60.7	19.9
9/26/2006	0.00	67.8	20.5
9/27/2006	0.00	67.8	26.1
9/28/2006	0.00	69.7	25.1
9/29/2006	0.00	69.5	25.4
9/30/2006	0.00	72.8	21.8
September 2006 Summary	1.34	77.5	16.9

October 2006

10/1/2006	0.00	68.0	29.4
10/2/2006	0.03	62.5	34.4
10/3/2006	0.01	61.7	31.2
10/4/2006	0.00	54.8	31.5
10/5/2006	0.29	49.7	33.0
10/6/2006	1.79	45.5	35.3
10/7/2006	0.00	56.3	26.6
10/8/2006	0.00	55.4	24.7
10/9/2006	0.26	41.8	29.0
10/10/2006	0.47	44.8	22.6
10/11/2006	0.01	52.4	25.2
10/12/2006	0.00	59.0	24.3
October 2007 Summary (partial)	2.86	68.0	22.6

May 2007

5/1/2007	0.00	66.4	32.3
5/2/2007	0.01	62.2	37.6
5/3/2007	0.03	43.3	26.0
5/4/2007	0.19	38.6	27.0
5/5/2007	0.01	37.5	25.6
5/6/2007	0.00	38.6	24.2
5/7/2007	0.00	56.8	18.8
5/8/2007	0.00	63.0	21.3
5/9/2007	0.00	66.7	23.3
5/10/2007	0.00	73.2	25.8
5/11/2007	0.00	75.4	28.6
5/12/2007	0.00	75.1	32.9
5/13/2007	0.00	74.9	38.3
5/14/2007	0.00	67.5	30.3
5/15/2007	0.00	68.4	21.4
5/16/2007	0.00	67.3	25.6
5/17/2007	0.00	68.5	28.1
5/18/2007	0.00	70.5	29.4
5/19/2007	0.00	69.8	29.8
5/20/2007	0.00	71.8	27.0
5/21/2007	0.01	66.2	32.8
5/22/2007	0.01	47.6	23.8
5/23/2007	0.00	52.4	22.1
5/24/2007	0.00	55.0	15.1

5/25/2007	0.00	67.4	19.0
5/26/2007	0.00	66.7	26.1
5/27/2007	0.00	73.4	27.2
5/28/2007	0.00	71.3	31.9
5/29/2007	0.00	59.4	27.0
5/30/2007	0.00	64.7	17.3
5/31/2007	0.00	69.6	21.8
May 2007 Summary	0.26	75.4	15.1

June 2007

6/1/2007	0.00	71.9	29.1
6/2/2007	0.00	75.1	27.8
6/3/2007	0.00	70.9	32.5
6/4/2007	0.00	77.0	32.8
6/5/2007	0.00	73.2	33.1
6/6/2007	0.23	56.5	31.2
6/7/2007	0.00	48.2	25.7
6/8/2007	0.00	63.9	19.4
6/9/2007	0.00	71.4	25.1
6/10/2007	0.00	75.3	28.7
6/11/2007	0.00	72.0	36.7
6/12/2007	0.00	69.9	30.2
6/13/2007	0.00	75.2	26.1
6/14/2007	0.00	78.9	33.1
6/15/2007	0.00	84.8	34.5
6/16/2007	0.00	86.8	38.8
6/17/2007	0.00	78.1	43.8
6/18/2007	0.00	75.8	33.5
6/19/2007	0.00	83.7	31.4
6/20/2007	0.00	86.7	32.3
6/21/2007	0.00	84.0	35.8
6/22/2007	0.00	85.3	36.7
6/23/2007	0.00	87.0	34.7
6/24/2007	0.00	88.4	37.9
6/25/2007	0.00	82.5	44.2
6/26/2007	0.00	83.5	32.9
6/27/2007	0.00	84.4	34.7
6/28/2007	0.00	86.3	34.3
6/29/2007	0.00	87.0	35.1
6/30/2007	0.00	86.6	34.7
June 2007 Summary	0.23	88.4	19.4

July 2007

7/1/2007	0.00	87.9	32.5
7/2/2007	0.00	90.9	34.4
7/3/2007	0.00	87.0	38.7
7/4/2007	0.00	88.2	37.0
7/5/2007	0.00	85.7	43.8
7/6/2007	0.10	85.4	39.0

7/7/2007	0.00	82.9	40.8
7/8/2007	0.00	83.0	41.1
7/9/2007	0.00	87.3	37.5
7/10/2007	0.00	87.7	37.9
7/11/2007	0.00	83.8	40.6
7/12/2007	0.01	72.5	41.2
7/13/2007	0.00	84.8	39.1
7/14/2007	0.02	82.9	41.1
7/15/2007	0.00	84.5	39.4
7/16/2007	0.00	82.4	40.2
7/17/2007	0.18	71.6	53.4
7/18/2007	0.00	84.3	45.0
7/19/2007	0.00	87.3	50.1
7/20/2007	0.00	84.1	40.1
7/21/2007	0.00	80.0	55.3
7/22/2007	0.00	83.8	43.1
7/23/2007	0.00	81.9	48.6
7/24/2007	0.00	75.0	45.3
7/25/2007	0.00	75.8	48.4
7/26/2007	0.54	71.5	43.9
7/27/2007	0.00	79.7	47.8
7/28/2007	0.47	75.5	45.5
7/29/2007	0.00	78.1	45.6
7/30/2007	0.00	79.6	45.9
7/31/2007	0.00	83.4	45.4
July 2007 Summary	1.32	90.9	32.5

August 2007

8/1/2007	0.41	79.7	47.6
8/2/2007	0.26	69.7	51.8
8/3/2007	0.01	73.8	47.6
8/4/2007	0.00	75.0	44.5
8/5/2007	0.13	75.2	49.4
8/6/2007	0.01	77.2	44.4
8/7/2007	0.00	79.2	40.1
8/8/2007	0.00	80.5	37.6
8/9/2007	0.00	78.3	37.6
8/10/2007	0.00	81.8	36.3
8/11/2007	0.00	86.6	36.6
8/12/2007	0.00	87.0	42.6
8/13/2007	0.14	82.7	44.9
8/14/2007	0.01	76.6	46.3
8/15/2007	0.00	79.3	46.9
8/16/2007	0.08	80.9	43.4
8/17/2007	0.15	73.7	52.3
8/18/2007	0.04	73.9	47.7
8/19/2007	0.00	81.5	42.6
8/20/2007	0.00	84.0	44.0
8/21/2007	0.00	84.8	38.1
8/22/2007	0.00	87.3	37.6

8/23/2007	0.00	81.0	43.0
8/24/2007	0.00	81.1	38.3
8/25/2007	0.00	86.0	37.2
8/26/2007	0.59	80.4	42.2
8/27/2007	0.22	65.0	45.5
8/28/2007	0.01	75.7	37.8
8/29/2007	0.01	77.2	40.9
8/30/2007	0.00	82.7	41.5
8/31/2007	0.00	76.0	44.8
August 2007 Summary	2.07	87.3	36.3

September 2007

9/1/2007	0.00	76.4	39.9
9/2/2007	0.00	79.3	42.5
9/3/2007	0.04	77.3	43.7
9/4/2007	0.16	74.5	38.7
9/5/2007	0.10	70.1	44.0
9/6/2007	0.01	67.3	35.9
9/7/2007	0.00	74.5	30.8
9/8/2007	0.00	78.0	33.1
9/9/2007	0.00	72.6	34.0
9/10/2007	0.00	72.2	34.9
9/11/2007	0.00	67.1	30.2
9/12/2007	0.00	79.0	29.7
9/13/2007	0.00	79.4	28.6
9/14/2007	0.00	77.4	38.6
9/15/2007	0.00	73.6	31.0
9/16/2007	0.00	74.7	33.7
9/17/2007	0.00	67.7	26.0
9/18/2007	0.00	69.5	23.4
9/19/2007	0.00	69.0	21.8
9/20/2007	0.00	71.9	23.9
9/21/2007	0.00	73.8	27.6
9/22/2007	0.76	62.8	33.0
9/23/2007	0.12	54.7	31.0
9/24/2007	0.00	44.1	22.6
9/25/2007	0.00	55.3	16.7
9/26/2007	0.00	64.6	20.3
9/27/2007	0.00	63.7	20.3
9/28/2007	0.00	58.7	27.2
9/29/2007	0.04	51.5	24.4
9/30/2007	0.03	49.8	12.1
September 2007 Summary	1.26	79.4	12.1

October 2007

10/1/2007	0.42	59.9	19.8
10/2/2007	0.00	59.5	25.7
10/3/2007	0.00	65.5	23.9
10/4/2007	0.00	71.6	27.7

10/5/2007	0.20	53.9	34.5
10/6/2007	0.01	38.1	25.3
10/7/2007	0.00	44.2	19.3
10/8/2007	0.00	52.8	18.0
10/9/2007	0.00	57.3	19.9
10/10/2007	0.00	64.4	22.2
10/11/2007	0.00	65.8	21.4
10/12/2007	0.00	54.9	24.5
10/13/2007	0.00	49.6	21.5
10/14/2007	0.00	51.7	21.7
10/15/2007	0.00	59.1	17.2
10/16/2007	0.03	53.0	21.1
10/17/2007	0.07	36.2	22.5
10/18/2007	0.03	47.5	19.2
10/19/2007	0.00	63.7	25.7
10/20/2007	0.00	56.1	21.2
10/21/2007	0.06	34.6	14.3
10/22/2007	0.00	52.0	8.2
10/23/2007	0.00	63.0	20.3
10/24/2007	0.00	60.1	16.8
10/25/2007	0.00	60.3	19.0
10/26/2007	0.00	64.2	18.9
10/27/2007	0.00	61.3	20.3
10/28/2007	0.00	60.5	21.4
10/29/2007	0.00	56.6	20.4
10/30/2007	0.00	52.6	25.7
10/31/2007	0.00	54.7	18.7
October 2007 Summary	0.82	71.6	8.2

November 2007

11/1/2007	0.00	56.7	15.5
11/2/2007	0.00	53.8	9.7
11/3/2007	0.00	59.7	5.6
11/4/2007	0.00	63.1	10.4
11/5/2007	0.00	60.1	8.1
11/6/2007	0.00	60.7	14.6
11/7/2007	0.00	60.5	16.1
11/8/2007	0.00	63.1	20.4
11/9/2007	0.00	55.6	16.7
11/10/2007	0.00	60.0	20.8
11/11/2007	0.00	52.1	18.5
11/12/2007	0.00	50.6	17.5
11/13/2007	0.00	58.7	17.4
11/14/2007	0.00	50.3	9.9
11/15/2007	0.00	50.9	8.3
11/16/2007	0.00	55.5	15.6
11/17/2007	0.00	55.2	21.6
11/18/2007	0.00	59.3	16.0
11/19/2007	0.00	61.5	15.3
11/20/2007	0.00	45.7	17.3

11/21/2007	0.00	28.9	-5.1
11/22/2007	0.00	27.0	-6.0
11/23/2007	0.00	34.7	4.4
11/24/2007	0.00	41.6	-1.9
11/25/2007	0.00	50.1	1.7
11/26/2007	0.00	40.3	3.3
11/27/2007	0.00	46.8	-0.6
11/28/2007	0.03	23.6	1.1
11/29/2007	0.00	46.8	0.9
11/30/2007	0.00	33.1	5.0
November 2007 Summary	0.03	63.1	-6.0

December 2007

12/1/2007	0.31	34.1	15.6
12/2/2007	0.17	29.4	-6.4
12/3/2007	0.19	34.5	-6.5
12/4/2007	0.00	47.1	8.5
12/5/2007	0.00	50.5	16.9
12/6/2007	0.00	41.3	15.5
12/7/2007	0.50	34.2	18.0
12/8/2007	0.06	27.7	8.2
12/9/2007	0.10	26.4	-10.9
12/10/2007	0.10	29.5	-13.7
12/11/2007	0.02	23.7	-13.0
12/12/2007	0.08	31.2	-18.3
12/13/2007	0.01	22.8	-11.1
12/14/2007	0.00	16.9	-7.4
12/15/2007	0.04	27.3	-21.1
12/16/2007	0.01	25.9	-13.4
12/17/2007	0.06	32.8	-10.8
12/18/2007	0.01	27.8	-7.4
12/19/2007	0.11	30.9	0.9
12/20/2007	0.09	28.3	2.2
12/21/2007	0.00	18.8	4.2
12/22/2007	0.11	27.4	-18.0
12/23/2007	0.00	26.5	12.2
12/24/2007	0.00	35.0	6.4
12/25/2007	0.00	16.9	-17.6
12/26/2007	0.02	21.0	-21.0
12/27/2007	0.00	11.0	-16.2
12/28/2007	0.00	18.0	-24.3
12/29/2007	0.00	23.8	-14.1
12/30/2007	0.00	26.9	11.5
12/31/2007	0.00	13.1	-23.2
December 2007 Summary	1.99*	50.5	-24.3

* Freezing conditions at precipitation gauge

January 2008

1/1/2008	0.08	23.1	-25.1
1/2/2008	0.00	31.2	-10.7

1/3/2008	0.00	29.0	-2.2
1/4/2008	0.01	33.5	9.6
1/5/2008	0.07	31.8	20.2
1/6/2008	0.01	26.3	5.3
1/7/2008	0.00	22.6	-8.4
1/8/2008	0.00	25.1	-10.9
1/9/2008	0.00	24.7	10.4
1/10/2008	0.00	32.3	-6.2
1/11/2008	0.02	26.5	6.0
1/12/2008	0.09	26.4	-2.9
1/13/2008	0.01	29.1	-4.0
1/14/2008	0.06	39.0	-16.8
1/15/2008	0.00	33.6	-3.2
1/16/2008	0.00	9.3	-23.1
1/17/2008	0.00	16.8	-22.0
1/18/2008	0.00	22.0	-7.1
1/19/2008	0.00	31.8	-5.2
1/20/2008	0.00	25.1	-12.4
1/21/2008	0.00	21.5	4.6
1/22/2008	0.13	28.6	-11.7
1/23/2008	0.04	25.8	-17.0
1/24/2008	0.06	25.3	-6.1
1/25/2008	0.10	31.8	-11.4
1/26/2008	0.02	30.6	-10.8
1/27/2008	0.07	25.9	0.4
1/28/2008	0.12	28.6	6.5
1/29/2008	0.08	22.1	-8.5
1/30/2008	0.00	15.5	-0.9
1/31/2008	0.20	27.1	-23.6
January 2008 Summary	1.17*	39.0	-25.1

* Freezing conditions at precipitation gauge

February 2008

2/1/2008	0.11	23.1	-7.2
2/2/2008	0.03	21.9	-3.7
2/3/2008	0.00	28.8	0.7
2/4/2008	0.00	30.8	10.6
2/5/2008	0.01	48.0	-4.7
2/6/2008	0.01	30.9	-2.1
2/7/2008	0.04	36.1	10.4
2/8/2008	0.00	32.5	14.7
2/9/2008	0.00	39.1	2.8
2/10/2008	0.00	46.3	-2.4
2/11/2008	0.00	34.7	13.6
2/12/2008	0.00	43.1	8.2
2/13/2008	0.00	42.5	3.0
2/14/2008	0.09	21.4	-14.4
2/15/2008	0.00	33.3	-15.8
2/16/2008	0.00	35.2	-5.8
2/17/2008	0.00	28.5	5.4
2/18/2008	0.00	46.9	0.3

2/19/2008	0.00	41.0	-6.8
2/20/2008	0.07	32.1	5.0
2/21/2008	0.01	37.0	0.7
2/22/2008	0.31	34.0	7.8
2/23/2008	0.56	40.4	-2.7
2/24/2008	0.00	40.8	18.7
2/25/2008	0.22	37.6	20.3
2/26/2008	0.01	47.6	-3.8
2/27/2008	0.00	48.2	-2.8
2/28/2008	0.00	52.7	7.3
2/29/2008	0.00	49.8	-2.1
February 2008 Summary	1.47*	52.7	-15.8

* Freezing conditions at precipitation gauge

March 2008

3/1/2008	0.00	50.6	6.1
3/2/2008	0.00	23.1	2.7
3/3/2008	0.00	37.3	-16.6
3/4/2008	0.00	31.6	11.9
3/5/2008	0.00	26.2	-14.0
3/6/2008	0.00	31.3	4.6
3/7/2008	0.00	46.4	0.5
3/8/2008	0.00	36.7	14.3
3/9/2008	0.00	41.8	5.5
3/10/2008	0.00	43.6	4.7
3/11/2008	0.00	48.7	1.8
3/12/2008	0.00	41.1	13.3
3/13/2008	0.00	41.0	13.0
3/14/2008	0.05	30.2	7.2
3/15/2008	0.08	31.8	-2.5
3/16/2008	0.14	27.8	-6.0
3/17/2008	0.02	32.5	1.5
3/18/2008	0.00	38.4	13.1
3/19/2008	0.00	49.2	3.6
3/20/2008	0.00	40.0	14.9
3/21/2008	0.00	39.7	13.6
3/22/2008	0.00	38.6	7.9
3/23/2008	0.00	47.8	-4.7
3/24/2008	0.00	51.7	7.8
3/25/2008	0.00	48.2	16.0
3/26/2008	0.00	47.1	23.0
3/27/2008	0.00	39.5	20.4
3/28/2008	0.00	40.8	9.5
3/29/2008	0.00	44.8	21.3
3/30/2008	0.00	39.6	24.3
3/31/2008	0.22	25.0	-4.1
March 2008 Summary	0.51*	51.7	-16.6

* Freezing conditions at precipitation gauge

April 2008

4/1/2008	0.00	42.0	-9.3
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4/2/2008	0.00	44.8	11.6
4/3/2008	0.01	36.1	17.4
4/4/2008	0.00	47.5	0.8
4/5/2008	0.00	40.5	20.4
4/6/2008	0.00	43.2	16.6
4/7/2008	0.09	33.8	18.9
4/8/2008	0.00	41.1	9.3
4/9/2008	0.06	34.7	18.8
4/10/2008	0.00	28.9	17.7
4/11/2008	0.01	33.1	17.4
4/12/2008	0.00	50.7	7.3
4/13/2008	0.00	55.7	13.9
4/14/2008	0.00	59.2	17.4
4/15/2008	0.00	56.8	21.5
4/16/2008	0.00	27.1	17.3
4/17/2008	0.00	43.4	16.0
4/18/2008	0.00	55.6	14.5
4/19/2008	0.00	61.0	19.1
4/20/2008	0.00	43.6	20.5
4/21/2008	0.00	43.2	12.5
4/22/2008	0.00	56.7	18.0
4/23/2008	0.00	53.4	23.4
4/24/2008	0.00	38.2	22.4
4/25/2008	0.00	46.7	11.0
4/26/2008	0.00	44.8	19.1
4/27/2008	0.00	56.8	8.6
4/28/2008	0.00	66.6	18.6
4/29/2008	0.00	68.8	26.4
4/30/2008	0.00	47.1	20.0
April 2008 Summary	0.17	68.8	-9.3

May 2008

5/1/2008	0.00	32.6	15.9
5/2/2008	0.00	45.6	19.1
5/3/2008	0.00	52.8	13.5
5/4/2008	0.00	59.1	21.1
5/5/2008	0.00	64.1	23.6
5/6/2008	0.00	61.6	24.8
5/7/2008	0.00	59.4	25.2
5/8/2008	0.00	51.2	29.7
5/9/2008	0.00	54.7	20.4
5/10/2008	0.02	54.9	22.3
5/11/2008	0.00	65.9	17.6
5/12/2008	0.00	47.1	29.2
5/13/2008	0.00	48.9	16.7
5/14/2008	0.00	52.3	26.2
5/15/2008	0.00	54.6	30.2
5/16/2008	0.00	68.4	23.1
5/17/2008	0.00	71.0	27.1
5/18/2008	0.00	73.5	28.0

5/19/2008	0.00	71.8	27.0
5/20/2008	0.00	78.5	32.2
5/21/2008	0.00	55.5	31.9
5/22/2008	0.31	35.9	27.7
5/23/2008	0.36	41.0	25.4
5/24/2008	0.08	46.7	22.1
5/25/2008	0.02	53.9	26.9
5/26/2008	0.07	48.2	28.9
5/27/2008	0.00	59.5	22.0
5/28/2008	0.00	65.4	26.9
5/29/2008	0.00	60.6	26.5
5/30/2008	0.00	63.3	22.9
5/31/2008	0.00	69.9	26.5
May 2008 Summary	0.86	78.5	13.5

June 2008

6/1/2008	0.00	74.5	27.0
6/2/2008	0.00	69.5	30.0
6/3/2008	0.00	67.4	36.5
6/4/2008	0.26	53.9	31.4
6/5/2008	0.00	50.0	30.5
6/6/2008	0.00	68.6	25.2
6/7/2008	0.00	54.4	27.8
6/8/2008	0.00	57.5	26.5
6/9/2008	0.00	70.8	19.9
6/10/2008	0.00	75.0	30.8
6/11/2008	0.00	53.1	25.7
6/12/2008	0.00	57.4	17.5
6/13/2008	0.00	71.6	17.7
6/14/2008	0.00	78.2	24.5
6/15/2008	0.00	81.0	28.9
6/16/2008	0.00	80.5	30.7
6/17/2008	0.00	82.0	31.7
6/18/2008	0.00	80.5	36.9
6/19/2008	0.00	75.0	33.0
6/20/2008	0.00	80.1	28.9
6/21/2008	0.00	80.6	31.7
6/22/2008	0.00	79.7	37.0
6/23/2008	0.00	79.4	39.8
6/24/2008	0.01	80.4	34.2
6/25/2008	0.00	80.9	35.7
6/26/2008	0.00	79.7	39.4
6/27/2008	0.00	81.5	34.0
6/28/2008	0.00	81.2	36.5
6/29/2008	0.00	78.8	37.9
6/30/2008	0.00	83.3	36.9
June 2008 Summary	0.27	83.3	17.5

July 2008

7/1/2008	0.00	82.8	42.7
7/2/2008	0.00	83.1	36.1
7/3/2008	0.00	87.5	36.4
7/4/2008	0.00	82.8	44.2
7/5/2008	0.00	73.2	42.0
7/6/2008	0.00	80.2	34.1
7/7/2008	0.00	78.0	33.8
7/8/2008	0.00	81.8	35.4
7/9/2008	0.00	85.5	35.2
7/10/2008	0.00	85.1	35.3
7/11/2008	0.00	83.3	36.7
7/12/2008	0.00	82.9	37.2
7/13/2008	0.00	80.5	41.3
7/14/2008	0.00	78.6	45.9
7/15/2008	0.00	83.0	49.3
7/16/2008	0.02	72.3	50.8
7/17/2008	0.00	79.8	36.5
7/18/2008	0.00	82.5	42.9
7/19/2008	0.00	86.8	37.8
7/20/2008	0.02	76.5	47.1
7/21/2008	0.06	72.4	47.1
7/22/2008	0.15	76.8	44.0
7/23/2008	0.00	83.0	42.8
7/24/2008	0.00	86.5	40.8
7/25/2008	0.00	81.9	42.8
7/26/2008	0.00	77.1	42.5
7/27/2008	1.41	78.1	45.2
7/28/2008	0.01	78.1	43.0
7/29/2008	0.00	80.4	42.0
7/30/2008	0.00	83.2	41.9
7/31/2008	0.00	86.5	41.6
July 2008 Summary	1.67	87.5	33.8

August 2008

8/1/2008	0.00	88.3	41.8
8/2/2008	0.02	77.0	52.7
8/3/2008	0.00	83.9	47.8
8/4/2008	0.00	80.9	45.2
8/5/2008	0.16	80.5	51.4
8/6/2008	0.03	66.0	52.4
8/7/2008	0.45	65.2	49.3
8/8/2008	0.01	70.8	44.9
8/9/2008	0.03	73.3	46.0
8/10/2008	0.00	79.4	41.8
8/11/2008	0.00	78.0	40.1
8/12/2008	0.00	77.7	37.8
8/13/2008	0.00	79.1	41.4
8/14/2008	0.00	80.0	37.0
8/15/2008	0.00	75.2	38.0
8/16/2008	0.00	71.3	29.7

8/17/2008	0.00	75.1	30.9
8/18/2008	0.00	79.4	34.6
8/19/2008	0.00	82.4	38.7
8/20/2008	0.00	81.6	43.7
8/21/2008	0.00	83.8	37.0
8/22/2008	0.00	85.9	43.9
8/23/2008	0.00	84.3	37.5
8/24/2008	0.00	82.0	39.4
8/25/2008	0.01	79.5	37.4
8/26/2008	0.00	81.3	37.9
8/27/2008	0.00	78.8	37.2
8/28/2008	0.00	80.3	36.8
8/29/2008	0.00	85.7	27.7
8/30/2008	0.00	80.3	34.7
8/31/2008	0.10	66.0	42.6
August 2008 Summary	0.81	88.3	27.7

September 2008

9/1/2008	0.03	56.2	30.7
9/2/2008	0.00	62.4	17.4
9/3/2008	0.00	69.1	25.1
9/4/2008	0.00	73.5	26.5
9/5/2008	0.00	69.5	31.9
9/6/2008	0.00	73.8	32.8
9/7/2008	0.00	77.3	26.8
9/8/2008	0.00	78.6	29.7
9/9/2008	0.22	64.1	34.0
9/10/2008	0.09	69.1	34.0
9/11/2008	0.01	62.1	29.6
9/12/2008	0.00	67.0	25.0
9/13/2008	0.00	70.8	25.5
9/14/2008	0.00	74.2	24.6
9/15/2008	0.00	74.6	26.7
9/16/2008	0.00	75.5	26.5
9/17/2008	0.00	70.6	32.1
9/18/2008	0.00	66.0	29.1
9/19/2008	0.00	72.2	28.7
9/20/2008	0.00	69.1	34.3
9/21/2008	0.00	71.9	31.9
9/22/2008	0.00	63.1	33.8
9/23/2008	0.00	66.5	22.2
9/24/2008	0.00	71.7	23.1
9/25/2008	0.00	74.2	28.4
9/26/2008	0.00	71.4	30.9
9/27/2008	0.00	75.3	30.0
9/28/2008	0.25	73.5	30.4
9/29/2008	0.00	69.6	31.7
9/30/2008	0.00	74.1	30.5
September 2008 Summary	0.60	78.6	17.4

October 2008

10/1/2008	0.00	73.0	28.7
10/2/2008	0.00	72.2	29.1
10/3/2008	0.01	62.3	37.0
10/4/2008	0.72	45.2	35.8
10/5/2008	0.00	48.0	28.9
10/6/2008	0.00	56.1	25.9
10/7/2008	0.00	63.5	23.5
10/8/2008	0.00	68.9	26.0
10/9/2008	0.00	67.4	25.4
10/10/2008	0.00	59.0	22.4
10/11/2008	0.00	46.4	20.1
10/12/2008	0.00	36.6	11.1
10/13/2008	0.00	38.9	4.2
10/14/2008	0.00	55.2	8.3
10/15/2008	0.00	57.7	15.6
10/16/2008	0.00	63.5	18.5
10/17/2008	0.00	64.9	21.6
10/18/2008	0.00	64.5	21.0
10/19/2008	0.00	60.2	23.7
10/20/2008	0.06	56.6	25.7
10/21/2008	0.01	52.1	23.8
10/22/2008	0.00	49.4	7.8
10/23/2008	0.00	58.1	17.4
10/24/2008	0.00	55.3	19.2
10/25/2008	0.00	66.1	23.5
10/26/2008	0.00	58.8	22.7
10/27/2008	0.00	64.0	18.4
10/28/2008	0.00	67.8	21.6
10/29/2008	0.00	66.7	21.2
10/30/2008	0.00	65.3	21.4
10/31/2008	0.00	55.6	22.1
October 2008 Summary	0.80	73.0	4.2

November 2008

11/1/2008	0.00	58.0	28.9
11/2/2008	0.45	43.7	27.0
11/3/2008	0.01	44.2	20.8
11/4/2008	0.05	40.2	22.3
11/5/2008	0.03	25.3	15.8
11/6/2008	0.01	36.5	8.3
11/7/2008	0.00	49.1	15.5
November 2008 Summary (partial)	0.55	58.0	8.3

Comparison of Weather Data and Stream Discharge

At the Sufco Mine During 2008

Introduction

This report provides an analysis and discussion of the relationship between climatic variability and stream discharge rates in the Pines area at the Canyon Fuel Company, LLC, Sufco Mine during 2008. The information used in this analysis includes the information provided herein and information provided previously to the Utah Division of Oil, Gas and Mining.

Climate Data

A weather station was installed in the upper East Fork of Box Canyon in August 2004. The station is fully automated and records precipitation and temperature data hourly during the ice-free period of the year. Because the tipping precipitation gage is not heated, precipitation falling as snow during cold periods of the year may not be included in the daily precipitation totals. During the winter season, the station is usually closed. Weather data from the East Fork weather station are available from mid-August 2004 to early November 2004, from mid-May 2005 to late October 2005, from late April to mid-October 2006, and from May 2007 to mid-November 2008. These data have been used in the flow comparisons presented below.

A National Weather Service weather station (Saline 24E) is also maintained near the Sufco Mine surface facilities. This weather station is operated year-round and records precipitation amounts (as direct rainfall or as snow-water equivalent). Information from this weather station is also used in the flow comparisons presented below. A plot of yearly precipitation at the Salina 24E for the period 1984 to 2008 as percentages of normal is presented in Figure 1.

The Palmer Hydrologic Drought Index (PHDI) has also been used in the flow comparisons presented below. A plot of the PHDI for Utah Region 4 is included in this analysis as Figure 2. The PHDI is a monthly numerical value generated by the National Climatic Data Center that indicates the severity of wet and dry spells. The PHDI is calculated from various hydrologic parameters including precipitation, temperature, evapotranspiration, soil water recharge, soil water loss, and runoff. Consequently, it is useful for evaluating the relationship between climatic conditions and groundwater and surface water discharge.

It is apparent in the plot of the PHDI that during the first half of 2008 the region (Utah Region 4) experienced a period of mostly near-normal to mildly wet conditions. During the second half of 2008, the region transitioned to a period of mild drought. It should be noted that the climatic conditions indicated in the PHDI for Utah Region 4 are calculated for a large region that includes most of central and south-central Utah. Additionally, because of the topographic setting and geologic conditions in the area, precipitation falling in the surrounding high-elevation mountainous areas is isolated from the Pines plateau area and

consequently does not contribute to groundwater recharge and surface-water flows in the Pines plateau area. Although regional climatic data are typically reflective of overall hydrologic conditions in the Pines area, measurements of precipitation falling in the local area is probably most useful in evaluating surface-water quantity and groundwater recharge rates. Locally, climatic data collected from the Salina 24E station during 2008 (Figure 1) indicates somewhat dryer conditions for the Sufco Mine area than that suggested by the regional climatic data. Precipitation measured at the Salina 24E station during 2008 was the lowest ever measured at the station (with 24 years of record). The annual precipitation measured at the station during eight of the last nine years has been below the station average, and each of the past three years has been dryer than the year preceding it, clearly indicating drought conditions in the area (Figure 1).

Precipitation measured at the East Fork weather station during the 7-month period from April through October 2008 was also meager and reflective of drought conditions; totaling only 5.18 inches (see attached Sufco East Fork weather station data and graphs on Figures 4 and 6).

Pines 407

Pines 407 is a surface-water monitoring station on the Main Fork of Box Canyon Creek just above the confluence with the East Fork of Box Canyon (see Figure 3 for location).

Discharge data are measured at Pines 407 using a 3-inch Parshall flume that is installed at the site. Flow measurements during the ice-free period are recorded using an electronic pressure transducer and data logger assembly installed at the flume. The site is inspected and

monitored quarterly and a manual flow measurement is performed. Discharge data at Pines 407 for 2008 are plotted together with temperature and precipitation data from the East Fork Weather Station and the PHDI for Utah Region 4 on Figure 4. Additionally, for the purposes of comparison, discharges from Pines 407 and Pines 408 are plotted together with a plot of the PHDI for Utah Region 4 for the period 2000-2008 in Figure 5.

The largest discharge measured at Pines 407 during 2008 took place on 28 April 2008 during a monitoring event that occurred early in the year because of a lack of snow cover (Figure 6). The discharge measured at that time (148 gpm) was the largest measured at the site in more than five years, and apparently not reflective of the drought conditions that prevailed at the site during 2008. This is attributable to the fact that such early season monitoring events have not been performed at the site because it does not usually become reasonably accessible until later in the season. The discharges measured at Pines 407 later during 2008 were generally similar to those measured during 2007 and somewhat lower than those measured in 2006, which is reflective of the overall drought conditions prevailing at the Box Canyon Creek drainage in the past three years (Figure 5). As is typical in Sufco Mine area drainages, discharge in Box Canyon Creek increased in the late fall as temperatures and sunlight hours decreased, vegetation became dormant, and corresponding decreases in evapotranspiration occurred. Although of different magnitude, overall discharge trends observed at Pines 407 in Box Canyon Creek during 2008 were similar to those observed at Pines 408 in the East Fork (Figure 5). This supports the conclusion that the discharge variability monitored at Pines 407 during 2008 is a reflection of climatic effects.

Pines 408

Pines 408 is a monitoring station on the East Fork of Box Canyon Creek just above the confluence with the main fork of Box Canyon Creek (see Figure 3 for location). Discharge data are measured at Pines 408 when accessible using a 3-inch Parshall flume that is installed at the site. Flow measurements during the ice-free period are recorded using an electronic pressure transducer and data logger assembly installed at the flume. The site is inspected and monitored quarterly and a manual flow measurement is performed. During an intense thunderstorm runoff event in the East Fork drainage on 27 July 2008, the Parshall flume at Pines 408 was washed out and transported away from the monitoring site. The pressure transducer and data logger were not recovered. Consequently, discharge measurements for a period of time during the summer were not available during 2008. Discharge data at Pines 408 for 2008 are plotted together with temperature and precipitation data from the East Fork Weather Station and the PHDI for Utah Region 4 in Figure 6. Additionally, for the purposes of comparison, discharges from Pines 407 and Pines 408 are plotted together with a plot of the PHDI for Utah Region 4 for the period 2000-2008 in Figure 5.

The largest discharge measured at Pines 408 during 2008 occurred on 28 April 2008 during a monitoring event that took place early in the year because of a lack of snow cover (Figure 6). The discharge measured at that time (36.9 gpm) was relatively high and apparently not reflective of the drought conditions that prevailed at the site during 2008 (Figure 5). This is attributable to the fact such that such early season monitoring events are not typically performed at the site because it does not usually become reasonably accessible until later in the season.

The discharges measured at Pines 408 later during 2008 were generally similar to those measured during 2007 and somewhat lower than those measured in 2006, which is reflective of the overall drought conditions prevailing at the Box Canyon Creek drainage in the past three years (Figure 5). As is typical in Sufco Mine area drainages, discharge in Box Canyon Creek increased in the late fall as temperatures and sunlight hours decreased, vegetation became dormant, and corresponding decreases in evapotranspiration occurred. Although of different magnitude, overall discharge trends observed at Pines 408 in The East Fork of Box Canyon Creek during 2008 were similar to those observed at Pines 407 in the main fork of Box Canyon Creek (Figure 5). This supports the conclusion that the discharge variability monitored at Pines 408 during 2008 is a reflection of climatic effects.

FP-1

FP-1 is a monitoring site on a specified reach of the stream channel in the upper west fork of the Main Fork of Box Canyon located between monitoring sites SUFCO 089 and GW-20 (See Figure 3). Monitoring at FP-1 occurs on or near October 1 of each year. Monitoring at FP-1 consists of the identification of the location of the first (uppermost) discharge in the stream on that date. A discharge measurement is also performed at this location. On 8 November 2008 there was no flow in the FP-1 stream section. Discharge was also not present in the stream reach when observed on 18 September 2008.

The first occurrence of continuous flow in the main fork of Box Canyon Creek on 8 November 2008 occurred at an approximate location as shown on Figure 3. A discharge of

0.304 gpm was measured at that time in the creek a short distance downstream. At locations higher in the stream drainage, zones of intermittent wetness were present.

FP-2

FP-2 is a monitoring site on a specified reach of stream in the North Water Canyon tributary of the East Fork of Box Canyon Creek between Pines 105 and the confluence with the East Fork of Box Canyon Creek (See Figure 3 for location). Monitoring at FP-2 occurs on or near October 1 of each year. Monitoring at FP-2 consists of the identification of the location of the perennial portion of the stream. There was no perennial stream flow at the confluence with the East Fork of Box Canyon Creek when the site was visited on 31 October 2008.

Discharge was also not present in the stream reach when observed on 12 September 2008.

Pines 106

Pines 106 is a monitoring location in Sufco's quarterly water monitoring plan. Pines 106 is located at the approximate location of site EFB-6, which is a flow-only monitoring site on the East Fork of Box Canyon Creek added to the monitoring plan in conjunction with the undermining of the stream with the 3 Left Pines East longwall panel. The location of Pines 106 is approximately coincident with the historical uppermost occurrence of perennial flow in the East Fork of Box Canyon Creek. Above this location, the stream is usually dry.

Discharge at Pines 106/EFB-6 is plotted in Figure 7. Discharge at monitoring site EFB-7, which is located on the East Fork a short distance below Pines 106/EFB-6 is also plotted on Figure 7. Typically, discharge in the East Fork increases rapidly through diffuse seepage from the underlying sandy substrate between Pines 106/EFB-6 and EFB-7. Also plotted

together with the discharge measurements in Figure 7 is a plot of precipitation data from the Salina 24E weather station. The yearly precipitation data are plotted on Figure 7 as deviations from the long-term (24 year) average precipitation.

It is apparent in Figure 7 that discharge near Pines 106 was meager during 2008. Although wetness was present near Pines 106 during early 2008, later in the year appreciable stream flow in the creek started near the EFB-7 location. The downward movement of the location of the first perennial discharge in the East Fork of Box Canyon Creek may be related to subsidence effects associated with mining in the underlying 4 Left Pines East longwall panel. However, the fact that appreciable stream discharge still occurs a short distance below EFB-6 demonstrates that the surface water has not been diverted away from the site or into deep rock strata underlying the creek.

It is apparent in the plot of discharge from EFB-7 and Pines 106/EFB-6 (Figure 7) that discharge in the drainage at EFB-7 continued during 2008 at levels not inconsistent with those anticipated for the prevailing climatic (drought) conditions in the area during 2008 (as evidenced by the plots of yearly precipitation at the Salina 24E station in the Sufco permit area as shown in Figures 1 and 7).

USFS 109

USFS 109 is routinely monitored as part of Sufco's quarterly water monitoring program.

The site is located in the upper middle fork of the Main Fork of Box Canyon. There was no discharge measured during 2008 at USFS 109.

USFS 110

USFS 110 is routinely monitored as part of Sufco's quarterly water monitoring program.

The site is located in the upper main fork of Box Canyon Creek. There was no discharge measured during 2008 at USFS 110.

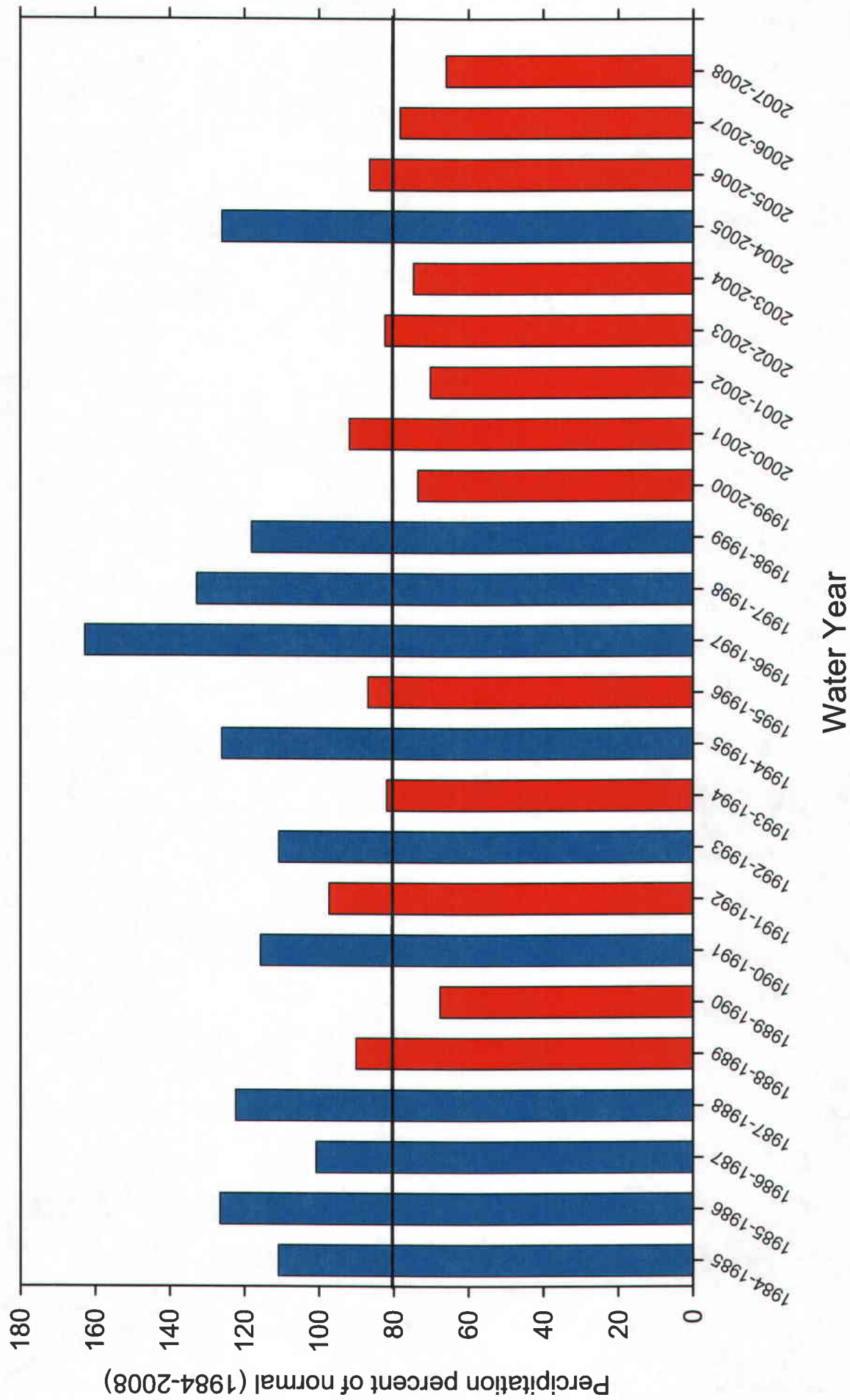


Figure 1 Sufco Mine Weather Station Precipitation

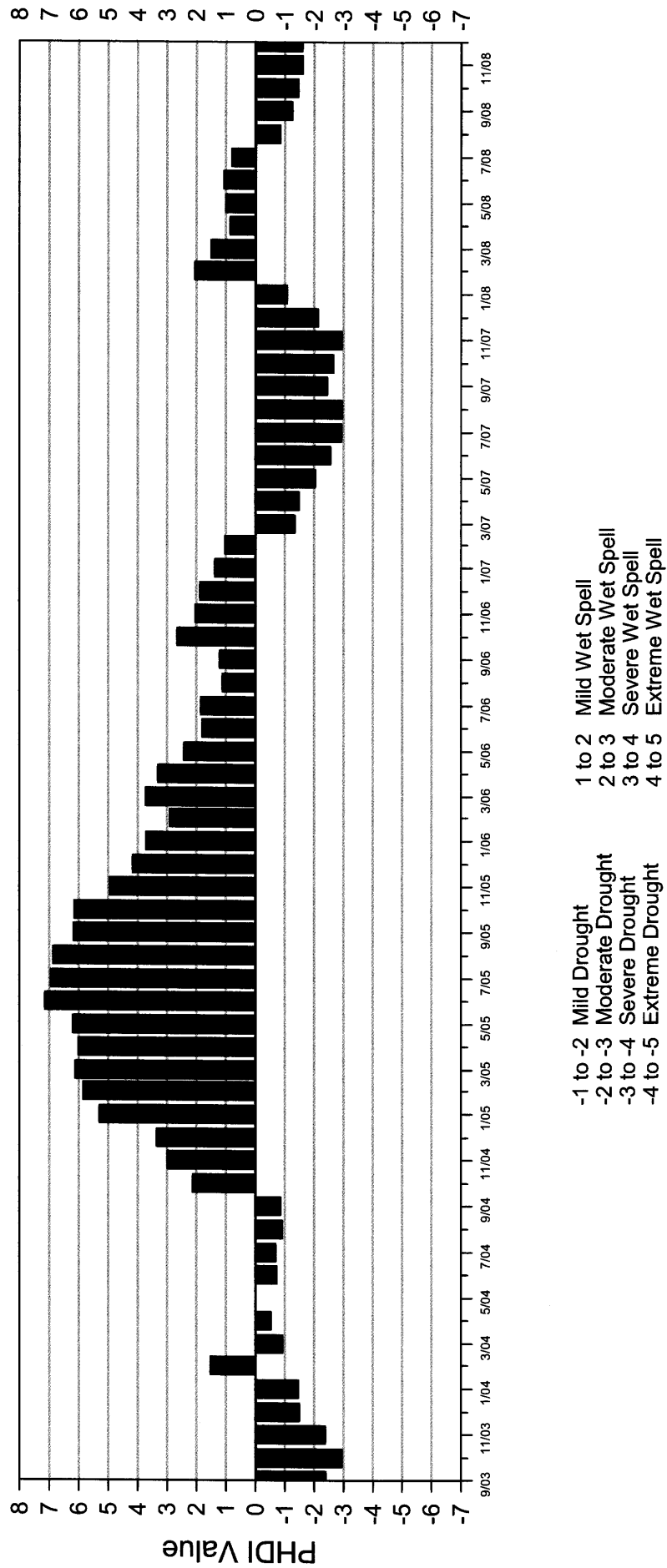


Figure 2 Plot of Palmer Hydrologic Drought Index for Utah Region 4.

N 39° 1' 39.387"



Map compiled from USGS 7½ Minute Quads: Flagstaff Peak; UT Emery West; UT

W 111° 18' 9.249"



Pines 407 (Main Fork of Box Canyon Creek) discharge and climate comparison

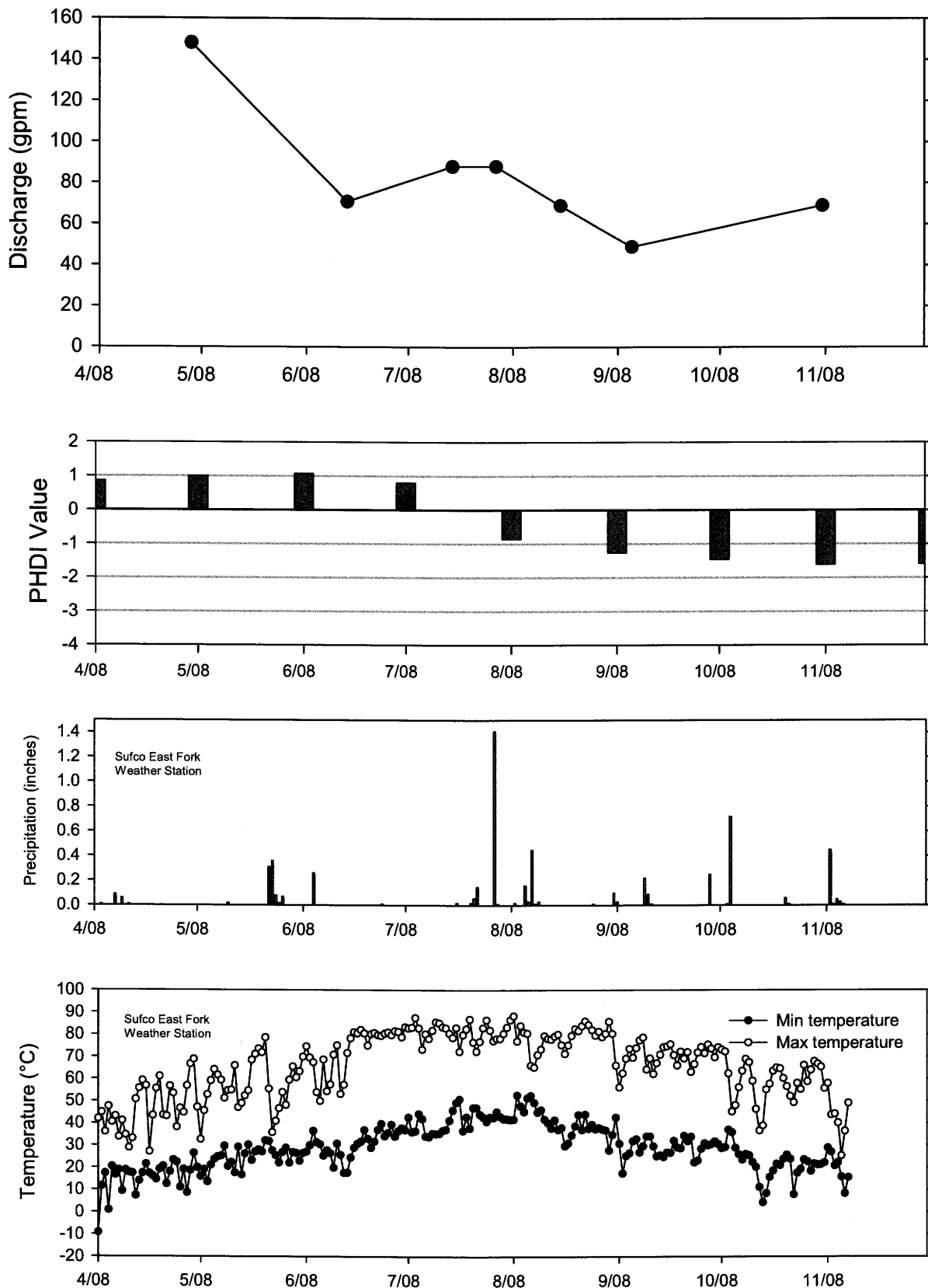


Figure 4 Pines 407 discharge and climate comparison.

Comparison of discharge rates and climatic conditions in Box Canyon 2000-2008
for Pines 407 (main fork) and Pines 408 (East Fork)

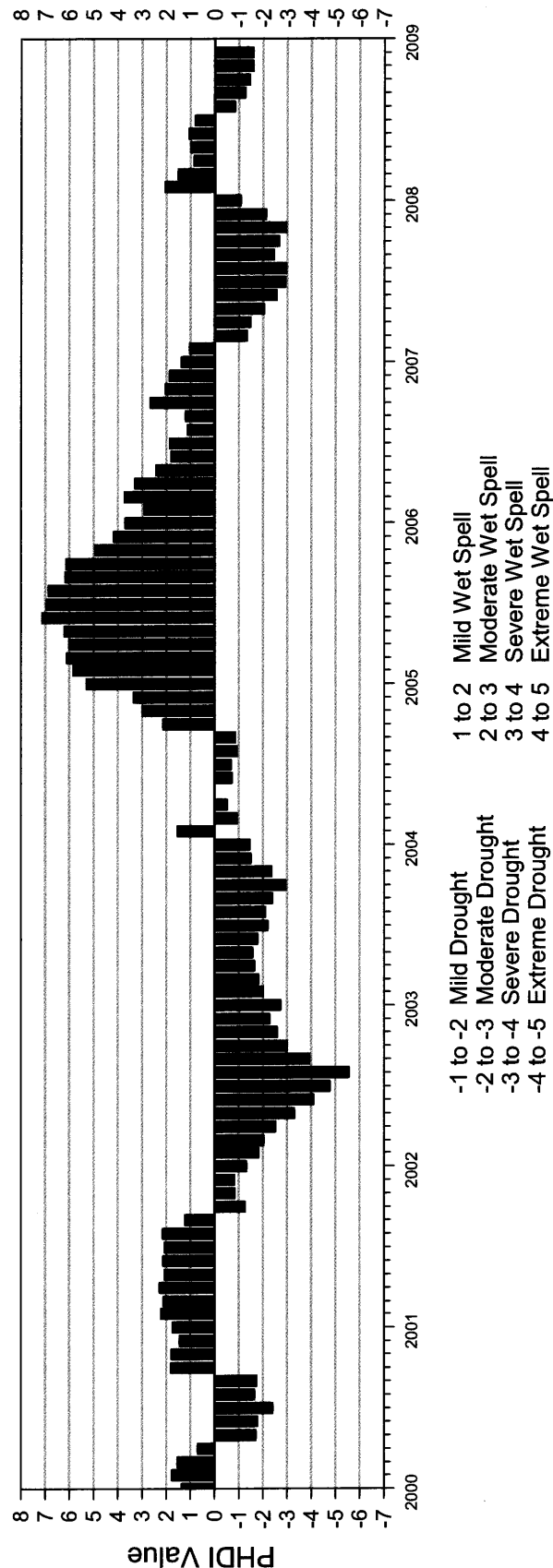
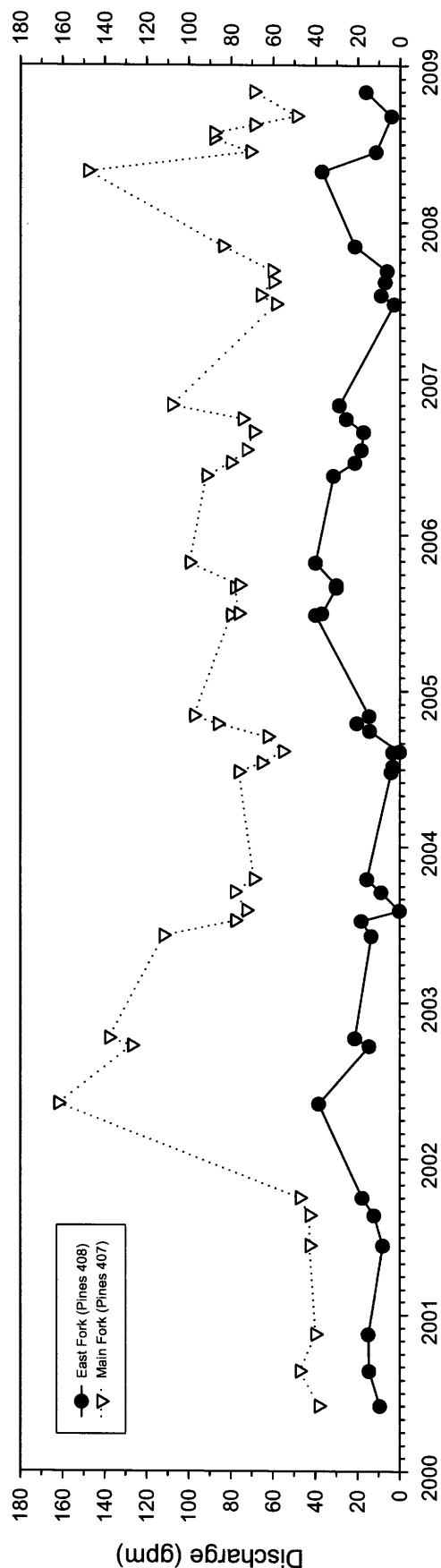


Figure 5 Discharge hydrographs for Pines 407 and Pines 408 and PHDI for Utah Region 4.

Pines 408 (East Fork of Box Canyon Creek)
discharge and climate comparison

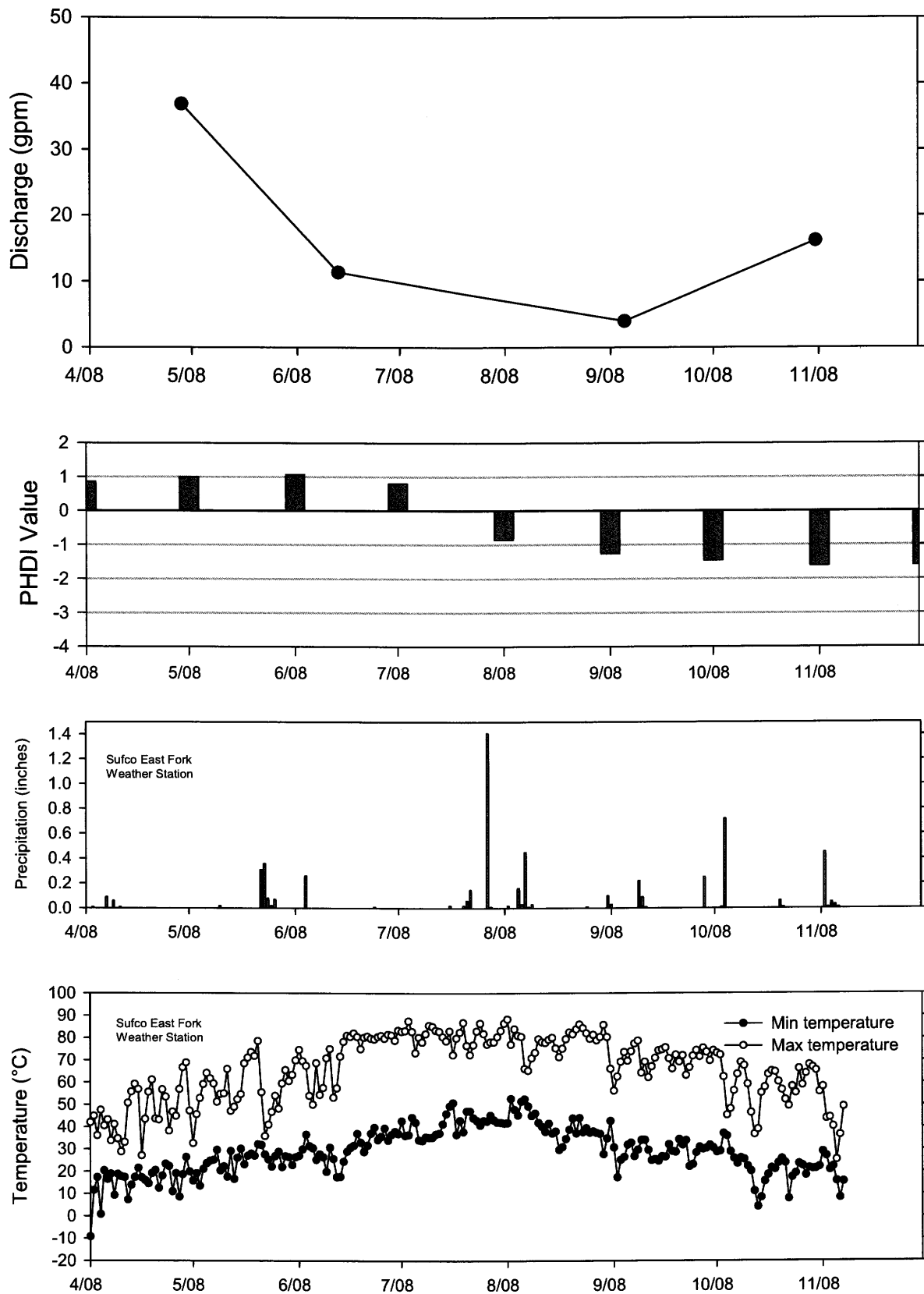


Figure 6 Pines 408 discharge and climate comparison.

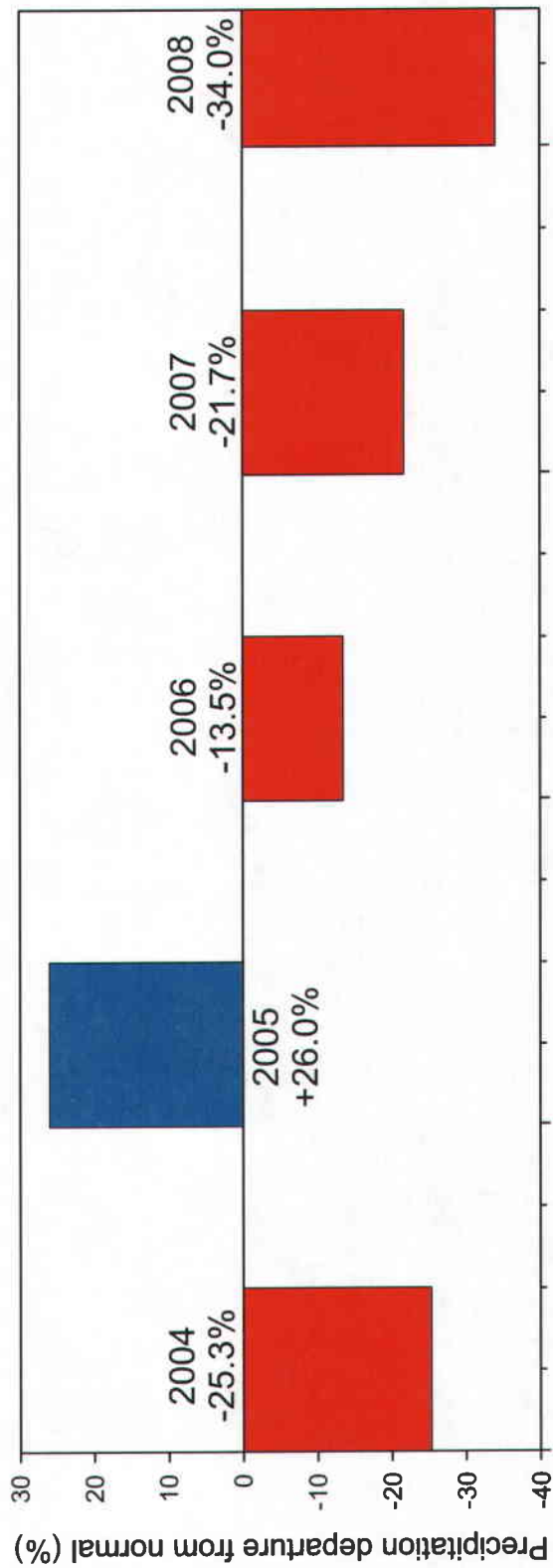
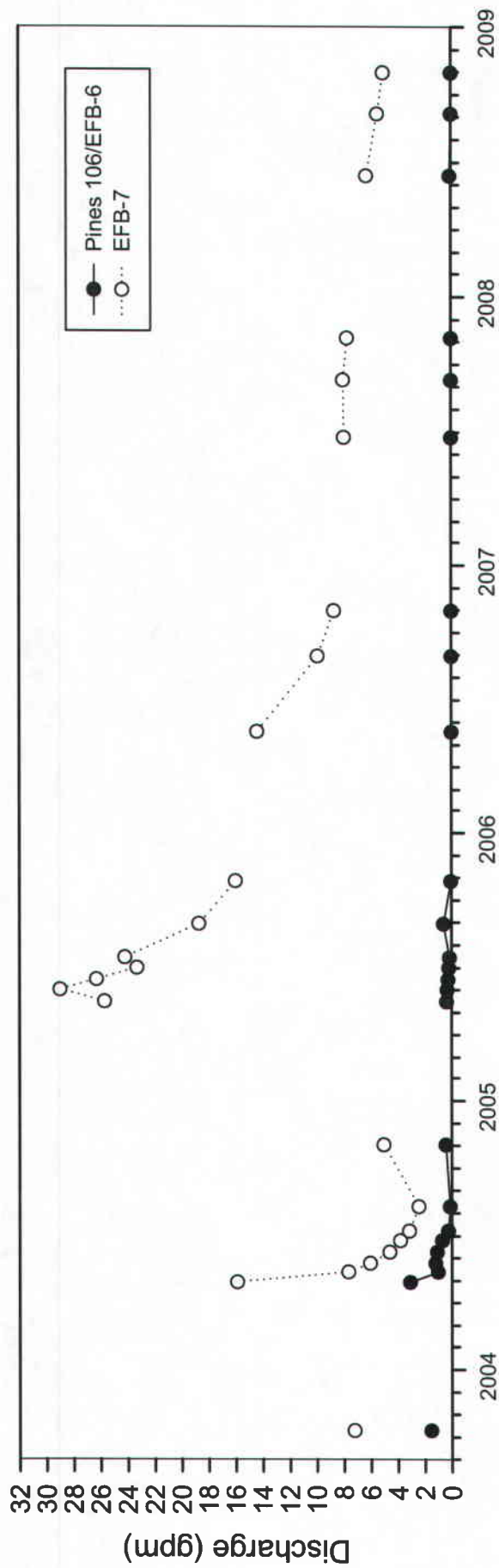


Figure 7 Pines 106/EFB-6 and EFB-7 discharge and Sufo Mine weather station data 2004-2008.

2008 SUBSIDENCE REPORT

CANYON FUEL COMPANY, LLC

SUFCO MINE

by

Keith B. Bigelow P.L.S.

INTRODUCTION

Canyon Fuel Company LLC, SUFCO Mine's 2008 subsidence report is an update of annual subsidence data that has been accumulated since 1976 as the former Southern Utah Fuel Company. Prior to 1985, the data was derived from conventional survey methods. Since then, photogrammetric surveys have been employed to monitor the ground movement.

During 1985, the entire SUFCO Mine property was flown to establish a set of baseline photography and a grid of surface elevations. Where possible, an elevation was photogrammetrically determined on an approximate 200-foot grid. These original x, y and z locations serve as a comparative base for determining ground movement in the succeeding years. Other lease holdings that are acquired are flown for similar baseline information. Lease U-63214 was flown in 1991 and the 150-acre modification to lease U-63214 and lease UTU-76195 were flown in 1999. Lease ML 49443-OBA was flown in 2006.

Once each year around the end of August, another set of aerial photography is obtained. A new elevation is then found at the same x and y coordinates as all the originals within all areas considered to be active. The new, or current, elevations are compared to the originals and the difference between the two is used to generate a contour map. The result is the subsidence contour map included with each annual subsidence report.

The mine subsidence map accompanying this report shows surface control monuments, overburden contours, subsidence contours, surface tension cracks, a current outline of the mine, a one year mining projection and other miscellaneous items as explained in the legend.

SUBSIDENCE HISTORY

SUFCO Mine began operations that cause surface subsidence in June 1976. Continuous miners were used to extract coal from pillars that were developed as part of a retreating panel. The panels were approximately 650 feet wide and varied in length up to 2,500 feet. The average mining height approached 11 feet and the extraction ratio averaged about 80%.

The resulting subsidence from these continuous miner panels averaged 4 feet in the plateau areas where overburden was 900 feet thick. In areas where panel boundaries were outside the escarpment and beyond the Castlegate Sandstone, subsidence increased with decreasing overburden thickness. The maximum subsidence measured to date, 8.5 feet, occurred in one of these areas. The overburden was only 600 feet thick.

Retreat mining continued in this manner until October, 1985, when a retreating longwall system was added. Longwall panels have ranged from 550 feet to 1,110 feet wide and up to 18,500 feet in length. Mining heights have varied from 8.5 feet to 12.5 feet.

Subsidence above the longwall panels has averaged 5 to 6 feet in the center of the panels. The overburden thickness has been from 1,000 feet to 1,800 feet (except outside the escarpment where overburden rapidly decreases). The maximum measured subsidence caused by longwall mining until 2007 was seven feet. This occurred in two cases: 1. An area outside the escarpment very similar to the one mentioned above for the continuous miner panel and 2. Down the center of panels that are under plateaus with 1,000 feet of overburden, but this is not typical. In 2007 there was a small area on the north end of the last longwall panel in area 12 that subsidence measured eight feet. This area has overburden of approximately 900 feet, and is relatively close to the escarpment. However, the data for this area in 2008 showed that it had settled with a maximum subsidence of seven feet.

DORMANT AND ACTIVE AREAS

Dormant areas are those areas that have shown no movement for several consecutive years. Yearly digitizing of these areas will not be done, but photographic coverage can be obtained in the event that a need should arise for reevaluation. These areas may not be shown on the current subsidence map.

Active areas are those currently being mined or that have evidence of movement within a reasonable time period. Active areas are digitized and evaluated for subsidence yearly, until they meet the parameters of a dormant area.

2008 SUBSIDENCE

The 2007 subsidence map (Map 1) was updated using data from current photogrammetric monitoring. Each subsidence area is labeled as an independent block. A brief description of each follows:

AREA 1

This was SUFCO Mine's first subsidence area. Undermining began in June 1976, and continued into 1979. The area is composed of five continuous miner panels that averaged 650 feet in width. Mining height averaged 11 feet with about an 80% extraction ratio.

Subsidence ranged from 4.5 feet to a maximum of 8.5 feet. It was first detected in 1976 and continued until 1985. No surface movement was detected in this entire area from 1986 to 1989. Area 1 has not been digitized since the 1990 subsidence report and is considered dormant.

AREA 2

This is another continuous miner area. The panels here were irregular shaped and the extraction ratio was modest. Undermining ceased in 1984.

Maximum subsidence has been measured at 2 feet. The area has been stable since 1985 and has not been monitored since 1989. This area is dormant.

AREA 3

This area is another continuous miner section, but the extracted area is a portion of mains with protective barriers instead of a panel. Coal recovery was moderate with mined areas which were subcritical. Undermining ceased in 1983.

Maximum subsidence was measured at 2 feet. Because of the limited extraction and subcritical areas, the subsidence occurred slowly with small changes noticeable until 1987. The area appeared stable in 1988 and 1989. It has not been monitored since 1989 and is considered dormant.

AREA 4

This subsidence area is comprised of three continuous miner panels. The mining height averaged 11 feet with a good extraction ratio. Undermining ceased in 1985.

Maximum subsidence was 5 feet with no detectable change in 1989. This area was monitored again in 1993, 1994 and 1995 with no detectable changes. This area was monitored for ten years after undermining ceased. The last detectable subsidence was in 1988. Therefore, this area is considered dormant.

AREA 5

The four continuous miner panels that make up this area were mined from September 1978, to November 1981. Mining height averaged 11 feet with an 80% extraction ratio.

Maximum subsidence was 5 feet with no detectable changes from 1985 through 1991. This area has not been monitored since 1991, and will also remain dormant.

AREA 6

Area 6 is SUFCO Mine's first longwall induced subsidence area. It is comprised of nine longwall panels varying from 540 feet to 700 feet in width and 1,700 feet to 3,900 feet in length. Also, there is a section of recovered mains between two of the longwall blocks. Undermining began in Area 6 during October, 1985, and continued through the mains recovery in March, 1990.

Maximum subsidence measured in areas bounded by the plateau is five feet. There is a location on the map that shows seven feet; but this area is outside the escarpment where the overburden is only 600 feet thick. The subsided escarpment is intentional and is part of a study agreed upon by SUFCO Mine, the Division of Oil, Gas and Mining, the Bureau of Land Management and the U.S. Forest Service. This particular section of escarpment was removed from the "no subsidence zone" to study the effects of longwall mining on the escarpment.

Area 6 has shown no significant changes since 1992. It has been determined that this area is dormant.

AREA 7

Area 7 was originally planned for no subsidence. Pillars were made to support the overburden but began to fail in the north end in 1984 when the underground workings were flooded. The failure progressed towards the south and by 1986 subsidence was detected over the area.

The map shows up to seven feet of subsidence. There was no additional subsidence movement detected from 1988 to 1994. Therefore, this area will also be considered dormant.

AREA 8

Undermining this area began in June 1983, and was sporadic until 1992. Continuous miners were used with extraction ratios over 80% and average mining heights of 10 feet. This area stayed active longer than most due to its proximity to an adjacent active longwall block.

Maximum subsidence is five feet. No noticeable vertical movement has been detected since 1993. This area is dormant.

AREA 9

This area is a longwall mining area that is composed of four panels. The first began in June 1989 and the block was finished in January 1992. The mining height averaged about 11 feet and the maximum subsidence is five feet. There has been no indication of movement since 1996. This area is determined to be dormant.

AREA 10

Area ten is a longwall mining block that began in January 1992. Mining was completed in August 2001. The entire surface area above this block was digitized for base-line elevations during 1991. Maximum subsidence shown to date is seven feet. This area has been mined out since 2001, and monitoring suggests that it has settled. It is now assumed to be dormant.

The experimental mining practice area discussed under "Area 6" was extended, with regulatory approval, to the east side of the canyon under the Southwest corner of "Area 10". An extensive pre-mining survey of this location was conducted late in 1992. A detailed survey of the post-mining subsidence effects was provided in the 1993 report.

AREA 11

Area eleven is an extension of the last longwall panel in Area ten. It extends into a 150-acre modification to lease U-63214. An elevation baseline was established in 1999. Mining under this area began in January 1999 with gateroad development. Longwall mining took place from May 2000 thru September 2000. Subsidence to date shows a maximum of six feet. This area has shown no significant movement since 2003 and is considered dormant.

AREA 12

Area twelve is the first longwall mining block on the acquired lease UTU-76195. Due to a mine plan change at the start of 2003, this area now consists of six longwall panels. An elevation baseline was established in 1999, and gateroad development began in March 2000. Longwall mining began in September 2001 and ended in February 2007. There was only a small amount of settling detected in the north end of the last longwall panel in this area between the 2007 and 2008 flight. This area appears to be stabilizing, but it will be monitored again in 2009.

AREA 13

Area thirteen is a longwall mining block consisting of seven panels on lease U-63214 and lease ML 49443-OBA. An elevation baseline for the area included on lease U-63214 was

established in 1991 and the elevation baseline for the area included on lease ML 49443-OBA was established in 2006. Longwall mining began in March 2007 and will continue until 2011. This area was considered active in 2007 and will continue to be monitored for several years.

DRAW ANGLE SURVEYS

Several draw angle surveys have been performed during the past years. Completed surveys have been over continuous miner areas and have been oriented both parallel and perpendicular to the long axis of the panel. The average of all measurements is 15° . Individual measurements ranged from 10° to 21° .

New longwall draw angle data was obtained in 1995. Draw angle points were installed in May 1986, on the southern end of the first panel in "Area 6". As shown on the subsidence map, survey lines were placed parallel and perpendicular to the axis of the panel. Undermining of this panel was completed in June 1986. Measurements were taken in 1995 and indicate an angle 15.25° for the perpendicular line. An angle for the parallel line was not obtained because the mains underlying the survey line were partially extracted. These findings coincide with the average of 15° as stated above.

SUBSIDENCE TENSION CRACKS

Tension cracks have occurred above most of the subsidence areas. Most have been located by survey and are shown on the map. Their lengths vary from a few feet to a couple thousand feet. Most are oriented either parallel to the natural jointing pattern or to the boundaries of the underground excavation. Vertical displacement along the cracks is uncommon and horizontal displacement varies from hairline to several inches in width depending on the surface topography (rock, hard packed or loose soil).

The U. S. Forest Service completed a tension crack study in 1978. They monitored twenty-two different cracks (located in Area 1) with widths varying from 1/8 inch to six inches. Results show that most cracks self-heal, or close, from 13% to 100% of their original width.

Longwall mining at the top of the 13L4E longwall panel caused some cracking in the escarpment sandstone of upper Box Canyon. The panel was mined parallel and down the center of a portion of the canyon. Subsidence thus created an inward pull on the canyon walls. These cracks are in the rock along the edge of the escarpment and vary in width and displacement. A monitoring program was initiated in 2004 to observe the behavior of these cracks. These cracks were checked in 2005 and again for the final time in 2008 and show no significant change in width or displacement. A chart of this data is included at the end of this report.

DETAILED LONGWALL SUBSIDENCE PROFILE

In 1998 a project was initiated to monitor longwall subsidence in relation to the advancing face. Preparation consisted of first installing two monitoring points outside the subsidence area. Then two base lines were established one 3000 feet long running parallel down the center and the second 1300 feet long perpendicular across the 967 feet wide panel. Markers were installed along these lines on 100 feet spacing using approximately 2.5 feet long rebar with an aluminum cap or a hardened nail drilled into the exposed rock. Initial horizontal and vertical readings were obtained by shooting each marker with a Topcon GTS-3 distance meter from the monitoring points.

Monitoring was done weekly to gather new readings on markers behind and up to 500 feet ahead of the advancing face. The data collected reveals that vertical movement starts approximately 150 feet ahead of the face with 15 hundredths of a foot of subsidence at the face. It then drops off quickly to 4 feet at 600 feet behind the face and gradually levels off at 4 to 5 feet. Horizontal readings indicate the ground initially moves about 30 hundredths of a foot away from the face, then back toward the face 80 hundredths of a foot.

CONCLUSION

Areas 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 are all considered to be dormant. Photographic coverage for these areas can be obtained if circumstances deem it necessary. There was active longwall mining in Area 12 until February of 2007 causing subsidence. Area 12 showed only a small amount of settling at the north end of the last longwall panel mined in this area between the 2007 and 2008 flight. Area 12 appears to be stabilizing, but will be monitored again in 2009. The baseline elevations for the new longwall panels on lease ML 49443-OBA in Area 13 were established in 2006, and longwall mining in this area began in March 2007. Subsidence monitoring in this area was started in 2007 and will continue for several years. The subsidence cracks in the escarpment along upper Box Canyon were checked again in 2008, and show no significant change in movement or displacement since last checked in 2005. These cracks will no longer be monitored unless circumstances arise that deem it necessary to check them again.

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BOX CANYON ESCARPMENT CRACKS

CRACK STATION SUFCO	WIDTH OF CRACKS	DROP OF CRACKS	X	Y	Z
BCE Crack 01 Sta 01			120843.93	131055.41	8369.66
AUGUST 2004	1.0'	0.50'			
SEPTEMBER 2005	1.05'	0.30'			
MAY 2008	0.95'	0.30'			
BCE Crack 01 Sta 02			120864.47	130972.33	8369.48
AUGUST 2004	1.7'	0.48'			
SEPTEMBER 2005	1.9'	0.50'			
MAY 2008	1.6'	0.50'			
BCE Crack 01 Sta 03			120903.89	130796.70	8370.63
AUGUST 2004	0.47'	0.35'			
SEPTEMBER 2005	0.47'	0.37'			
MAY 2008	0.47'	0.46'			
BCE Crack 02 Sta 01			121016.97	130673.02	8376.34
AUGUST 2004	0.08'	0.0'			
SEPTEMBER 2005	0.07'	0.0'			
MAY 2008	0.07'	0.0'			
BCE Crack 02 Sta 02			121024.30	130591.32	8373.91
AUGUST 2004	0.09'	0.0'			
SEPTEMBER 2005	0.07'	0.0'			
MAY 2008	0.06'	0.0'			
BCE Crack 03 Sta 01			120931.85	130817.12	8371.88
AUGUST 2004	0.33'	0.0'			
SEPTEMBER 2005	0.32'	0.0'			
MAY 2008	0.33'	0.0'			
BCE Crack 03 Sta 02			120940.62	130713.78	8373.38
AUGUST 2004	1.17'	0.01'			
SEPTEMBER 2005	1.15'	0.03'			
MAY 2008	0.71'	0.03'			
BCE Crack 03 Sta 03			120941.99	130593.20	8370.72
AUGUST 2004					
SEPTEMBER 2005	0.5'	0.3'			
MAY 2008	0.32'	0.24'			
BCE Crack 04 Sta 01			120291.04	131471.84	8366.01
AUGUST 2004	0.08'	0.03'			
SEPTEMBER 2005	0.08'	0.03'			
MAY 2008	0.07'	0.03'			
BCE Crack 04 Sta 02			120110.25	131468.03	8358.60
AUGUST 2004	0.04'	0.0'			
SEPTEMBER 2005	0.04'	0.0'			
MAY 2008	0.04'	0.0'			

PINES TRACT VEGETATION STUDY

**For
CANYON FUEL COMPANY, LLC
SUFCO MINE**

**Prepared by
Keith W. Zobell
8684 South 400 West
Spanish Fork, Utah 84660
Phone (801) 798-8926**

August 15, 2008

PINES TRACT VEGETATION STUDY

Prepared by
Keith W. Zobell, Environmental Specialist
August 15, 2008

The purpose of the "Pine Tract Vegetation Study" continues to be to determine if the under-mining of the coal reserves of the "Pine Tract" has had any affect on the "Link Canyon Trail Columbine (*Aquiligia flavescens* var. *rubicunda*) and the riparian areas within the "Pines Tract" coal lease.

On July 16, 2008 the "Pine Tract" area was visited by Keith W. Zobell, (Environmental Specialist) and Mike Davis (Mining Engineer) for Canon Fuel Company, SUFCO Mine. The purpose of the trip was to 1) revisit all of the original photographic points that have been established, 2) retake photographs at each of the sites and 3) to determine the general vegetation growth, plant vigor and plant condition at each of the established photographic sites. These sites are revisited each year at approximately the same date each year so as to reduce any possible seasonal variations. Photographs of each site are identified and included within this report.

The weather records at the SUFCO Mine site showed that it had received 56% of the normal moisture through the end of June 2008, for this moisture year. Although good snowfall was received during December, January and February the overall moisture for this moisture year is lower than at this time last year. This continued below average moisture is contributing to having a significant influence on the overall growth and vigor of the vegetative in this area. The overall growth is only fair and is similar or less than last year.

The stream in Box Canyon continues to be basically dry above water monitoring station 090. There are some short stream sections of intermittent flows above station 090 up to water monitoring station "Pines 219", with the stream being completely dry above this station. The small pond at the "Grotto" area continues to be dry, however the water that is dripping from the cliff faces above the pond area appears to be a little more than last year. The spring at station "Pines 105" and the area at photographic point 10 continues to be dry. However the riparian area continues to be green and growing which indicates that the area is still receiving some subsurface moisture for these riparian plants.

The "Pines Tract" grazing unit was the first unit to be grazed this year. Many of the sites were heavily grazed so that growth could not be determined for some species of plants. The plant growth and vigor can be attributed to the lack of moisture and heavy grazing this spring.



Photo Point 1a

At photo point 1a there is still one plant growing. It has a few inflorescences, which are 10-12 inches in length. There are about the same number of inflorescences as last year and the vigor is fair.



Photo Point 1b

At photo point 1b there are two columbine plants. One plant is in poor condition and appears to be dying while the other plant is healthy and has good vigor. Only the healthy plant has any inflorescence, which is 18-20 inches in length. Exact measurements cannot be made due to the location of the plants. These plants appear to be getting some moisture from the rock fractures that they are growing in.



Photo Point 1c

At photo point 1c there is only one columbine plant and it is located approximately 20-25 feet up on the cliff face, so exact measurements cannot be made. There has been one plant at this photographic point in the past. It now appears that the plant has died.



Photo Point 2

Last year there were three plants at this site, one dead, one dying and one in fair vigor. This year it appears that there are only two plants at this site, one dead and one that appears to be dying. The plants are located 20-25 feet up on the cliff face so exact measurements cannot be made. The inflorescence on the living plant appears to be 10-12 inches long and in fair condition.



Photo Point 3

At this photographic point there has been two plants in the past, however, this year (2008) both of the previously existing plants are gone. No reminiscent of either plant could be found. The area has been heavily grazed but it could not be determined if grazing caused the plants to disappear. There is one new columbine seedling growing underneath the edge of the rock.



Photo Point 4

At this photographic point there are several columbine plants. Only two of the plants have inflorescence. One plant has an inflorescence of 9 inches while the other has an inflorescence of 12 inches. Both plants have fair vigor. The *Carex* plants are sparse and have a basal growth of 2-3 inches. Woods Rose has a new twig growth of 1-2 inches with no flowers or seed heads. The *Potentilla* plant has a new twig growth of 1 inch. This is a very dry site and the overall site is of low vigor, which is probably due to lack of moisture. The site has not been grazed.



Photo Point 5

At this photographic point there are still three columbine plants. All three of the plants have been grazed. They have a basal growth of 3-4 inches and are in low vigor. The bluegrass has a sparse density and has been grazed down to the ground level and has no new re-growth. The *Carex* plants have been grazed and have a re-growth of 2-3 inches. The yarrow has no inflorescence and a basal growth of 2-3 inches. The Hairgrass has been grazed down to the ground level and is not visible. The site has approximately 30 percent bare ground with the remainder of the area having good ground litter. The overall vigor of the site is poor. There is no water in the creek at this site.



Photo Point 6

At this photographic point the site is dry and has been heavily grazed by livestock. Ocular estimate show that the site to have approximately 50% bare ground with only fair ground litter. Aspen has a new twig growth of 8-12 inches with the majority of the twigs having been grazed off. Woods Rose has a new twig growth of 4-8 inches with no flowers or seed heads. Yarrow has been heavily grazed with no inflorescence with a basal growth of 2-3 inches. Bluegrass has been grazed down to ground level. Herbaceous sage has been heavily grazed and a basal growth of 4-6 inches. *Carex* has been heavily grazed and has new re-growth of 2-3 inches. Wiregrass has been grazed down to 4-6 inch height and has a very low density. Overall the vigor at this site is poor. There is no water in the Creek.



Photo Point 7

At this photographic point there are still no columbine plants. The site has been heavily grazed by livestock, with none of the existing plants having any inflorescence. Geranium has a basal growth of 2-3 inches. Yarrow has a basal growth of 2 inches. *Carex* has a basal growth of 1 inch. Horsetail has a basal growth of 2 inches. No bluegrass plants could be found. The site is 90-95 % bare ground. Vigor is poor. There is no water in the Creek.



Photo Point 8

This photographic point is a hanging fern area located in the "Grotto" area. The ferns and the lichens receive moisture that is coming from the fractures in the cliff face. The fern density appears to be slightly more than last year with the ferns having a current growth of 4-6 inches. There also appears to be more lichens this year than last year. There is more moisture seeping from the fractures than last year. The seepage is too small of flow to be measured.



Photo Point 9a

At this photographic point there is moisture coming from the fractures in the cliff face and is located in the "Grotto" area. . The moisture appears to be more than last year. The moisture flow cannot be measured. The ledge is covered with a good growth of lichens. The ferns have a current growth of 5-7 inches.



Photo Point 9b

At this photo point there is moisture coming from the fractures in the cliff face and is located in the "Grotto" area. Some small pools of water have been formed from the dripping water. The lichen growth and density appears to have increased since last year. This increase in lichen growth appears to be at the expense of fern density, which is less than that of last year. The current growth of the ferns is 6-8 inches.



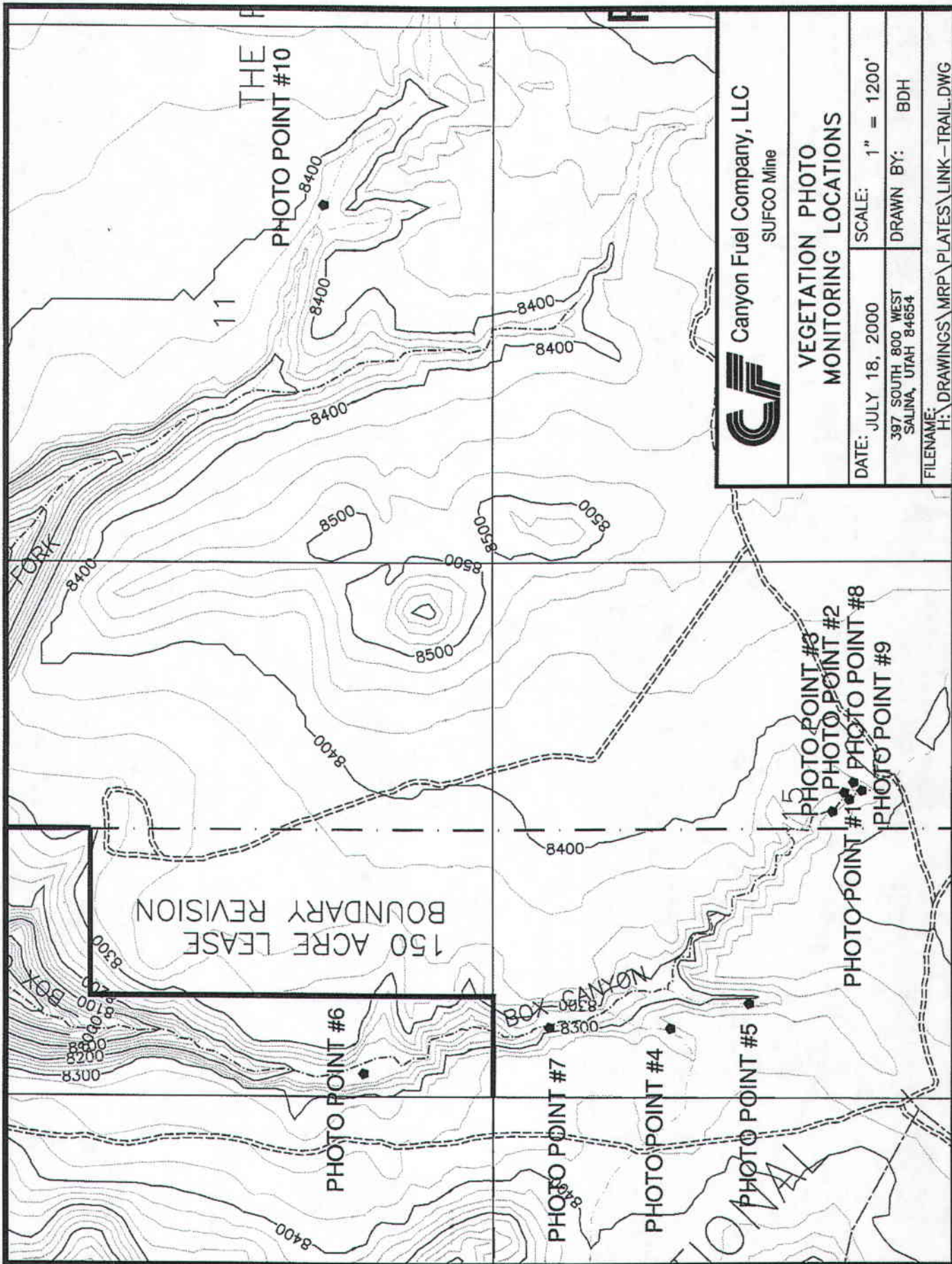
Photo Point 10

This photographic point was originally a dry meadow site but is fast becoming a dry sagebrush/grassland site. The site has been heavily grazed by domestic livestock, this year. All of the species on the site except sagebrush have been heavily grazed. The Aspen have some re-growth of 3-5 inches. The sagebrush has a current years growth of 4-6 inches. There were a few current years growth of woods rose found which had a current twig growth of 3 inches. The sparse density of wiregrass had been heavily grazed with a stubble height of 4 inches still remaining. All of the grass species have been grazed down to ground level. The overall condition and vigor of this site is very poor. Ocular estimate show the site to have 70% bare ground.



Riparian Area adjacent to Photo Point 10

This photograph shows a contrast between the grazed area and the fenced enclosure, which is adjacent to photographic point 10. Although spring "Pines 105" is not flowing the riparian area is still remaining green and showing good vigor in the protected area.



Canyon Fuel Company, LLC
SUFCO Mine

VEGETATION PHOTO MONITORING LOCATIONS

DATE: JULY 18, 2000	SCALE: 1" = 1200'
397 SOUTH 800 WEST SALINA, UTAH 84654	DRAWN BY: BDH
FILENAME: H:\DRAWINGS\MRP\PLATES\LINK-TRAIL.DWG	

LINK CANYON MINE PORTAL VEGETATION STUDY

**For
CANYON FUEL COMPANY, LLC
SUFCO MINE**

**Prepared by
Keith W. Zobell
8684 South 400 West
Spanish Fork, Utah 84660
Phone (801) 798-8926**

June 28, 2008

LINK CANYON MINE PORTAL VEGETATION STUDY

Prepared by
Keith W. Zobell, Environmental Specialist
June 28, 2008

Photographs were retaken at the Link Canyon Mine Portal area on June 13, 2008. The area has received 7.67 inches of moisture during this moisture year. Although good snow fall was received during December, January, and February overall the moisture this year is lower than at this time last year. This continued below average moisture is probably contributing to the vegetative condition of the site.



Link Canyon West Portal Photo Point

There is no water discharge from this portal and there is no evidence that there has been any. The Willow (*Salix spp.*) has suffered a severe die back. Approximate 60 % of aerial stems have died. It is difficult to determine if this die back is due to lack of moisture or

winter kill. On the living aerial stems the new growth is 6-10 inches and have not yet begin to flower. There is some basal sprouting on some of the plants where the aerial stems are dead. There are no insect galls on the willows at this time. Woods Rose (*Rosa woodsii*) has no blooms or indications that it will bloom. The current new growth on the Rose plants is 2-3 inches. Bluegrass (*Poa pratensis*) density is very low. The bluegrass has 6-8 inches of new growth, but no seed heads. The density of wiregrass (*Juncus balticus*) continues to be low. The wiregrass plants are just coming into bloom and have 8-10 inches of new growth. The Clematis (*Clematis ligusticifolia*) is just starting to leaf out and is starting this years growth. The Squawbush (*Rhus aromatica* var *trilobata*) has bloomed and has set some seed. The new growth is 2-3 inches in length. The overall growth and vigor of this site continues in a downward trend.



Link Canyon East Portal Photo Point

There is no water discharging from this portal and there is no evidence that there has been any. The density of wiregrass is approximately 40% and some of the plants are just coming into bloom. The current growth is 10-12 inches in length. Bluegrass plant

density is sparse with some plants producing seed heads. The current growth is 6-7 inches. The main dogwood bush (*Cornus stolonifera*) is approximately 70% dead. A small dogwood plant is showing some stress. Current growth on the dogwood 2-3 inches and is just starting to flower. The clematis plants are just starting to grow. The Gooseberry plant (*Ribes spp.*) has bloomed and set seed. The new growth is 2-3 inches. The Rabbitbrush (*Chrysothamnus nauseosus*) has a new growth of 2-3 inches. Most of the basal stems on the Rabbitbrush are dead. The willows are leafed out with 7-9 inches of new growth. There are no insect galls on the willows, and they have not yet begun to set flowers.

Overall the condition of the vegetation at both portals continues to be in downward trend.

LINK CANYON MINE PORTAL VEGETATION STUDY

**For
CANYON FUEL COMPANY, LLC
SUFCO MINE**

**Prepared by
Keith W. Zobell
8684 South 400 West
Spanish Fork, Utah 84660
Phone (801) 798-8926**

September 30, 2008

LINK CANYON MINE PORTAL VEGETATION STUDY

Prepared by
Keith W. Zobell, Environmental Specialist
September 30, 2008

The Link Canon Mine Portal area was subjected to flash flood event in mid-August 2008. Although the exact flow volume of the flash flood is not known it is event that the flood waters were at least 47 inches deep. This is known by the flood debris that was deposited on vegetation adjacent to the flood path. The vegetative study area at the West Portal was almost completely destroyed by this flood event as shown in Photo 1.

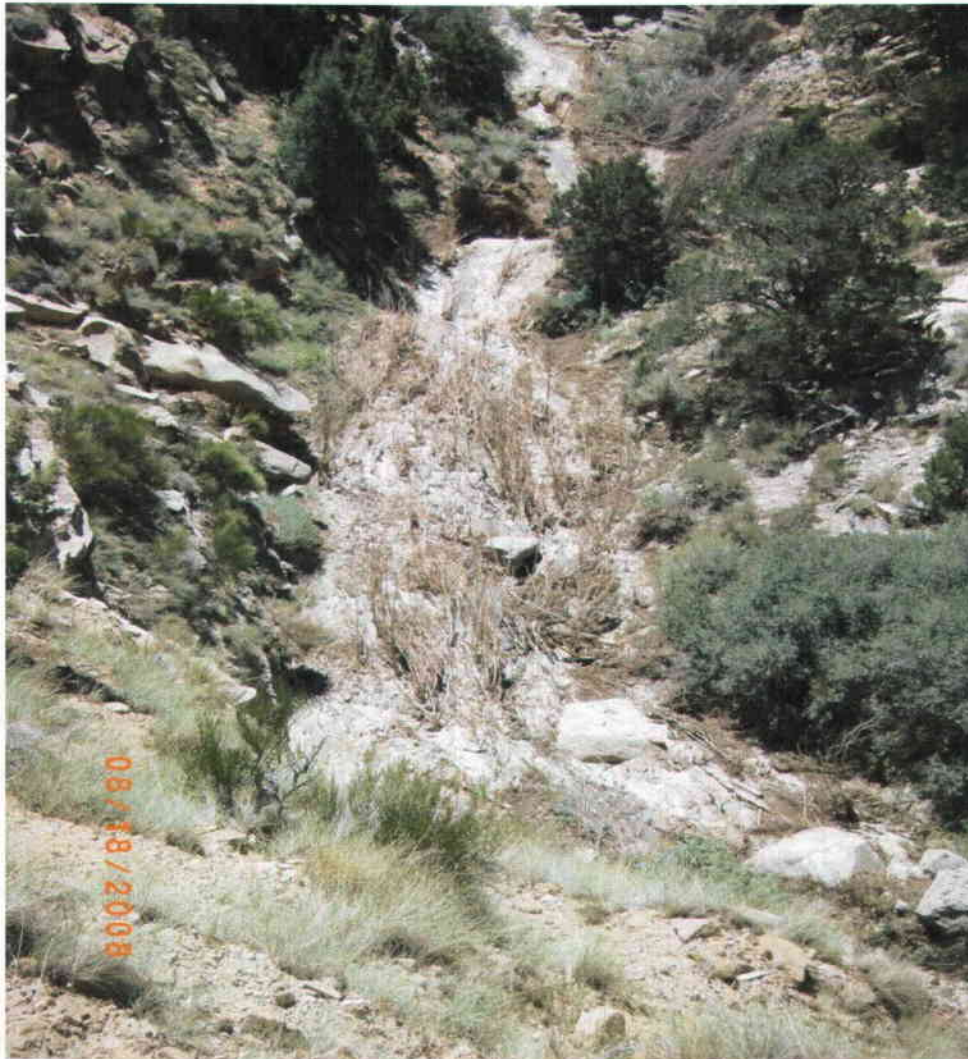


Photo 1- Flood damage at West Portal

The damage at the East Portal was not as severe. Although there was considerable damage to the site some of the riparian vegetation remained, (primarily *Juncus spp.*) Photo 2 shows the flood damage at the East Portal.



Photo 2-East Portal Area

Photographs were retaken at the Link Canyon Mine Portal Area on September 18, 2008. This area has received 8.93 inches of moisture during the 2007-2008 moisture year. This is 66% of the normal moisture for this year. During the moisture year for 2006-2007 the area received 10.59 inches of moisture which is 78% of normal. During the past nine years this area has received below average moisture eight of the nine years. There is no doubt that when the portals were reopened and that a low volume of moisture stopped flowing from the portals that it had an effect of the vegetation below the portals. However, below average moisture of eight of the past nine years has undoubtedly also had a detrimental affect on the vegetation.



Link Canyon West Portal Photo Point

The riparian vegetation at this site was almost completely destroyed except for one branch of the Squawbush (*Rhus aramatica* var. *trilobata*) and one small willow (*Salix* spp.) plant. The site has been reclaimed by the SUFCO Mine and has been seeded with the approved interim seed mix. It is possible that there could be some root sprouts from any remaining willow roots. However, the probability is quite small. Only time will tell. There is no water being discharged from this Portal.



Link Canyon East Portal Study Area

Flash flood waters were at least 47 inches deep at this portal as shown by debris on vegetation adjacent to the flood path. Much of the vegetation at this site has either been destroyed or severely damaged. Most of the aerial vegetation on the dogwood bush (*Cornus stolonifera*) is dead however, there is some new sprouting from the base of the plant. There is still considerable root masses of wiregrass (*Junus sp.*) remaining of the site which may grow next spring. The Rabbitbrush (*Chrysothamnus nauseosus*) and Clematis (*Clematis liquistifolia*) above the high water line are still surviving. It is impossible to tell if any other ground species survived. There was evidence of either the willow or *Ribes* species. The stake for taking the photo point photo was destroyed and will be reestablished.

LINK CANYON MINE PORTAL VEGETATION STUDY

**For
CANYON FUEL COMPANY, LLC
SUFCO MINE**

**Prepared by
Keith W. Zobell
8684 South 400 West
Spanish Fork, Utah 84660
Phone (801) 798-8926**

December 4, 2008

LINK CANYON MINE PORTAL VEGETATION STUDY

Prepared by
Keith W. Zobell, Environmental Specialist
December 4, 2008

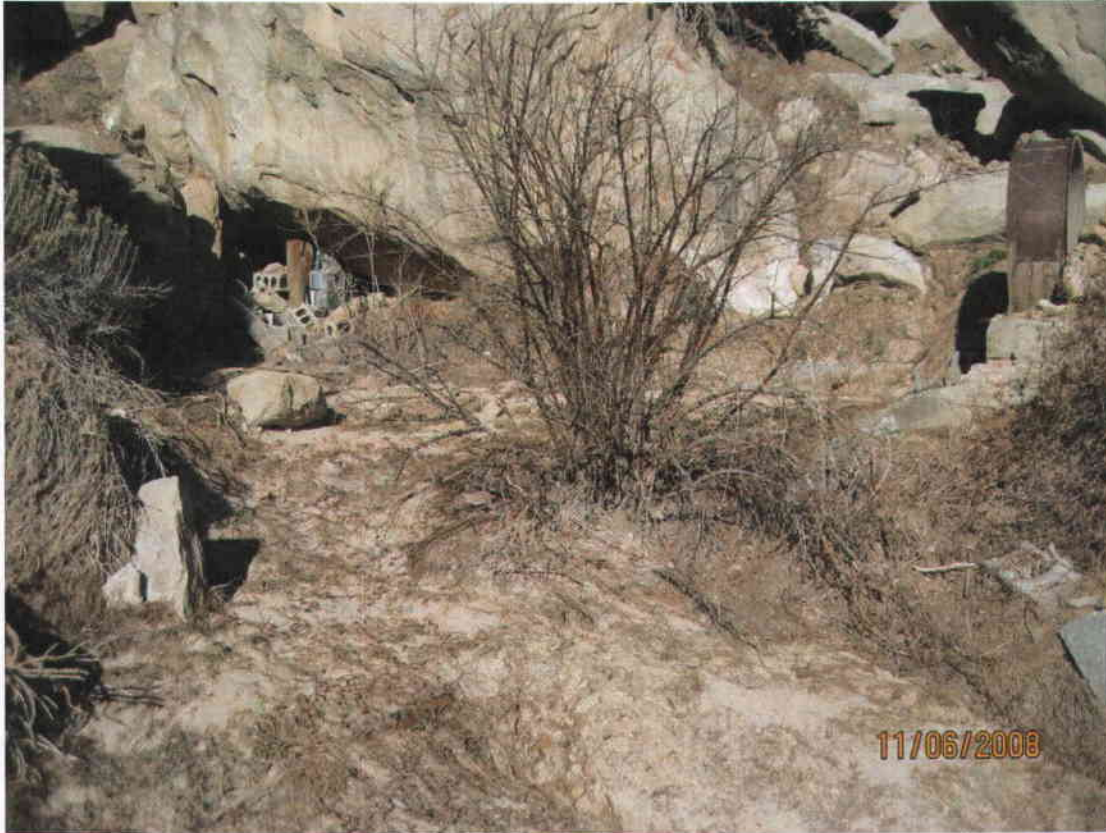
Photographs were retaken at the Link Canyon Mine Portal area on November 16, 2008. The Link Canyon Portal area has had no new growth on the existing vegetation since the last photographs were taken. This is due to the end of the growing season and the freezing nights that have been occurring for the past several weeks.



West Portal Area

There is no new growth on the Squawbush (*Rhus aramatica* var. *trilobata*) or on the willow (*Salix spp.*) plants that survived the flash flood in August this year. There are some grass seedlings starting to germinate on the area that was seeded with the interim seed mixture. The interim seed mixture consists of grass species only and includes the following species: Mountain Brome (*Bromus carinatus*), Giant Wildrye (*Elymus cinereus*), Western Wheatgrass (*Elymus smithii*), Bluebunch Wheatgrass (*Elymus*

spicatus), Slender wheatgrass (*Elymus trachycaulus*), Indian ricegrass (*Stipa hymneoides*).



East Portal Area

This site is completely dormant. The Rabbitbrush (*Chrysothamnus nauseosus*) above the flood line has bloomed and set some seed. Some of the basal sprouts of the Dogwood (*Cornus stolonifera*) bush appear to still be living. The other species at this site are dormant.

There is no water being discharged from either portal.

Waste Rock Disposal Site Material Analyses

Year	Quarter	Lab	Lab ID	EC				Total				T.S.		Neutral.		T.S.		Boron		Selenium		Alkalinity	
				pH	Saturation	@ 25° C	Calcium	Magnesium	Sodium	SAR	Sulfur	AB	U/1000t	Pot.	U/1000t	ABP	U/1000t	ppm	ppm	ppm	meq/L	PE	meq/L
2000	1	Int	0100S20484	7.0	49.6	3.96	23.50	14.70	8.69	1.99	0.32	10.00	78.2	52.9	41	68.2	7.73	7.73	0.02	0.02	1.57		
2000	2	Int	0100S20485	7.2	47.5	1.02	2.65	3.19	4.11	2.41	0.38	11.90	52.9	41	53.7	0.02	0.02	0.02	0.02	2.82			
2000	3	Int	0100S20486	6.9	55.5	3.82	21.10	8.81	11.50	2.98	0.41	12.80	52.4	39.6	49.5	0.02	0.02	0.02	0.02	2.16			
2000	4	Int	0100S20487	7.2	47.8	1.36	3.06	3.61	6.38	3.49	0.43	13.40	50.4	36.9	4.43	0.02	0.02	0.02	0.02	3.38			
2001	1	Int	0101S09020	7.3	45.1	4.50	28.10	15.70	14.20	3.03	0.54	16.90	92.1	75.2	6.84	< 0.02	< 0.02	< 0.02	< 0.02	1.44			
2001	2	Int	0101S11636	7.3	50.9	3.78	14.50	13.40	15.40	4.12	0.48	15.00	39.3	24.3	8.45	< 0.02	< 0.02	< 0.02	< 0.02	2.33			
2001	3	Int	0101S19152	7.0	40.2	9.19	39.20	27.10	35.30	6.14	0.44	13.70	89.8	76.1	5.28	< 0.02	< 0.02	< 0.02	< 0.02	2.11			
2001	4	Int	0101S23729	6.8	52.2	4.35	28.60	12.80	10.70	2.35	0.50	15.60	56.2	40.6	6.54	0.02	0.02	0.02	0.02	2.08			
2002	1	Int	0102S06276	6.9	39.7	12.40	43.70	32.10	60.80	9.87	0.43	13.40	91.2	77.8	5.28	< 0.02	< 0.02	< 0.02	< 0.02	2.31			
2002	2	Int	0102S12107	7.2	43.6	8.64	38.90	22.90	38.10	6.85	0.45	14.10	83.5	69.5	5.53	< 0.02	< 0.02	< 0.02	< 0.02	2.83			
2002	3	Int	0102S19293	7.4	46.8	4.27	26.00	22.00	8.61	1.76	0.79	24.70	56.6	32.0	7.61	0.04	0.04	0.04	0.04	1.81			
2002	4	Int	0102S24366	7.0	35.2	8.22	34.90	36.90	23.00	3.84	0.62	19.40	104.0	84.2	5.26	0.02	0.02	0.02	0.02	2.25			
2003	1	Int	0103S02028	7.4	51.5	4.80	15.40	8.75	21.30	6.12	0.41	12.80	50.2	37.4	2.66	< 0.02	< 0.02	< 0.02	< 0.02	1.79			
2003	2	Int	0103S07189	7.1	39.6	12.80	36.70	31.40	80.00	13.70	0.59	18.40	108.0	89.9	7.39	0.02	0.02	0.02	0.02	1.06			
2003	3	Int	0103S14524	7.2	53.3	2.43	14.60	7.84	8.45	2.53	0.57	17.80	44.2	26.4	6.03	< 0.02	< 0.02	< 0.02	< 0.02	1.94			
2003	4	Int	0103S19355	7.4	51.9	9.42	16.60	10.10	63.10	17.30	0.51	15.90	48.0	32.1	7.55	< 0.02	< 0.02	< 0.02	< 0.02	2.95			
2004	1	Int	0104S03718a	7.4	60.5	4.14	5.08	2.22	27.10	14.20	0.37	11.60	26.9	15.4	4.08	< 0.02	< 0.02	< 0.02	< 0.02	2.93			
2004	2	Int	0104S11683	7.3	44.2	8.38	31.30	21.10	39.30	7.67	0.48	15.00	41.1	26.1	13.30	0.04	0.04	0.04	0.04	3.47			
2004	3	Int	0104S14234	6.8	41.8	19.80	44.80	25.50	145.00	24.50	0.28	8.75	146.0	137.0	5.74	< 0.02	< 0.02	< 0.02	< 0.02	3.33			
2004	4	Int	0104S16558	7.1	47.5	6.21	35.50	13.00	21.40	4.35	0.40	12.50	61.5	49.0	7.56	0.02	0.02	0.02	0.02	3.06			
2005	1	Int	0105S01676	7.2	44.0	17.80	45.60	29.90	127.00	20.70	0.41	12.80	144.0	131.0	5.18	< 0.02	< 0.02	< 0.02	< 0.02	2.18			
2005	2	Int	0105S03977	7.5	61.9	2.05	7.44	4.47	7.17	2.94	0.27	8.43	156.0	147.0	2.96	< 0.02	< 0.02	< 0.02	< 0.02	1.85			
2005	3	Int	0105S08168	5.9	55.6	5.47	35.40	29.20	8.22	1.45	0.50	15.60	92.7	77.1	5.27	0.04	0.04	0.04	0.04	7.47			
2005	4	Int	0105S14664	6.9	41.5	7.99	40.30	23.60	40.20	7.11	0.39	12.20	129.0	116.0	7.16	0.02	0.02	0.02	0.02	1.45			
2006	1	Int	S0603345-001	7.3	55.6	2.55	4.79	2.62	17.10	8.88	0.23	7.29	83.9	76.6	1.04	< 0.02	< 0.02	< 0.02	< 0.02	3.01			
2006	2	Int	S0606464-001	7.2	47.1	8.45	26.80	33.40	39.00	7.11	0.62	19.30	87.9	68.7	8.71	0.03	0.03	0.03	0.03	3.97			
2006	3	Int	S0609044-001	7.1	45.6	8.74	38.30	30.40	32.20	5.50	0.31	9.73	115.0	105.0	10.00	0.04	0.04	0.04	0.04	2.61			
2006	4	Int	S0612385-001	6.9	76.3	12.50	19.10	10.80	78.90	20.40	0.34	10.60	67.4	56.7	0.96	< 0.02	< 0.02	< 0.02	< 0.02	2.38			
2007	1	Int	S0703426-001	6.9	66.5	61.50	52.80	24.40	520.00	83.70	0.61	18.90	71.6	52.7	4.20	< 0.02	< 0.02	< 0.02	< 0.02	2.30			
2007	2	Int	S0706194-001	7.3	46.5	17.90	38.10	29.70	78.70	13.50	0.35	10.90	127.0	116.0	4.07	0.04	0.04	0.04	0.04	1.67			
2007	3	Int	S0709354-001	7.4	43.4	12.60	43.40	39.20	63.80	9.92	0.47	14.70	130.0	115.0	5.82	0.04	0.04	0.04	0.04	3.78			
2007	4	Int	S0711304-001	7.5	42.5	3.68	9.00	7.63	19.30	6.68	0.44	13.70	64.7	51.0	2.56	< 0.02	< 0.02	< 0.02	< 0.02	3.18			
2008	1	Int	S0803064-001	7.8	43.7	14.60	8.47	3.84	124.00	50.10	0.30	9.38	59.3	49.9	2.58	< 0.02	< 0.02	< 0.02	< 0.02	2.49			
2008	2	Int	S0806139-001	7.1	44.9	35.00	32.90	18.60	283.00	55.90	0.35	10.80	55.0	44.2	4.99	< 0.02	< 0.02	< 0.02	< 0.02	3.22			
2008	3	Int	S0809030-001	7.1	44.2	8.40	38.30	23.20	40.50	7.31	0.32	10.00	167.0	157.0	5.36	0.05	0.05	0.05	0.05	2.80			
2008	4	Int	S0812121-001	7.4	37.5	8.45	36.60	23.80	56.30	10.30	0.30	9.47	130.0	121.0	3.90	0.04	0.04	0.04	0.04	2.96			
2009	1	Int	S0903295-001	7.5	53.7	25.50	16.60	10.20	239.00	65.20	0.39	12.30	25.4	13.1	1.27	< 0.02	< 0.02	< 0.02	< 0.02	2.37			
2009	2	Int																					
2009	3	Int																					
2009	4	Int																					
Minimum				5.9	35.2	1.02	2.65	2.22	4.11	1.45	0.23	7.29	25.4	13.1	0.96	< 0.02	< 0.02	< 0.02	< 0.02	1.06			
Maximum				7.8	76.3	61.50	52.80	39.20	520.00	83.70	0.79	24.70	167.0	157.0	13.30	0.05	0.05	0.05	0.05	7.47			
Average				7.2	48.5	10.45	26.98	18.33	65.32	13.94	0.43	13.51	83.2	69.6	5.50	0.02	0.02	0.02	0.02	2.63			

Riparian Plant Communities
in the
East Fork of Box Canyon
July 2008



A Vegetation Monitoring Study
for the
SUFCO Mine:
July 2008

Prepared by

MT. NEBO SCIENTIFIC, INC.

330 East 400 South, Suite 6
Springville, Utah 84663
(801) 489-6937

by

Patrick D. Collins, Ph.D.

for

CANYON FUEL COMPANY, LLC.

397 S SR 24
Salina, Utah 84654

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SCOPE

Quantitative and qualitative baseline vegetation data were recorded in several locations in the East Fork of Box Canyon in July 2008. Data were also recorded in several locations in the Main Fork of Box Canyon that may be used as "control" areas for the study.

Coal mining activities were scheduled and conducted under the East Fork of Box Canyon during the winter of 2003-04. This document provides the *eight*th sample period of baseline and subsequent monitoring data for the existing riparian plant communities in the two forks of Box Canyon. The *first* sample period was in the October 2003, prior to the mining activities below the East Fork (this final report was called *Riparian Plant Communities in the East Fork of Box Canyon: 2003*). The *second* sample period was in July 2004 after mining had occurred under the canyon (the final report was called *Riparian Plant Communities in the East Fork of Box Canyon: July 2004*). The *third* sample period was in October 2004 (*Riparian Plant Communities in the East Fork of Box Canyon: October 2004*). The *fourth* sample period was in July 2005 (*Riparian Plant Communities in the East Fork of Box Canyon: July 2005*). The *fifth* sample period was in October 2005 (*Riparian Plant Communities in the East Fork of Box Canyon: October 2005*). The *sixth* sample period was in July 2006 (*Riparian Plant Communities in the East Fork of Box Canyon: July 2006*). The *seventh* sample period was in October 2006 (*Plant Communities in the East Fork of Box Canyon: October 2006*).

INTRODUCTION

The Box Canyons and their drainages are located at the southern end of the Wasatch Plateau which is a subprovince of the Colorado Plateau Physiographic Province. This area is west of the town of Emery, Utah in Sevier County and is located within the Manti-LaSal National Forest. The Box Canyon drainages are tributaries to Muddy Creek which runs into the Dirty Devil River and ultimately drains into the Colorado River. Geology of the study areas were within the Cretaceous strata of the Mesa Verde Group. The upper portions of the study area were comprised of rocks and soils derived from the cliff-forming Castlegate Sandstone. The lower reaches of the study area encounters shales of the Blackhawk Formation. Elevation of the study area was between 8,000 ft to 8,500 ft above sea level.

This study concentrated on the riparian plant communities within the East Fork of Box Canyon because underground mining had been proposed in this area. However, because no mining was planned underneath the Main Fork of Box Canyon, some control transects were also placed in this drainage.

A variety of biological and other resource information can be studied to evaluate and characterize riparian complexes including vegetation, geology, channel morphology, aquatic biology, soils, and stream flow. The primary focus of this study was on the vegetation as to provide baseline and followup information by monitoring the riparian communities in the East Fork of Box Canyon. Regular monitoring was conducted to provide data that would determine long term trends,

natural variability and benchmark information including the possible impacts on the riparian plant communities from mining beneath the creek.

Like the previous studies, this study primarily employed vegetation monitoring methods described by the USDA Forest Service for a "Level III Riparian Area Evaluation". The design of this study was not to provide data that could show subtle changes to community structure and species composition as a result of *minor* changes to the riparian habitat. Rather, the study was designed to be compared with earlier (and future) studies in an attempt to document *major* impacts to the plant communities along the stream due to catastrophic events, such as loss of water and habitat from the effects of subsidence caused from underground mining.

METHODS

Sample station locations were pre-determined from an earlier field visit in 2003 by a team of specialists and representatives from the State of Utah, Division of Oil, Gas & Mining (DOGM), Canyon Fuel Company (CFC), USDA Forest Service (USFS), Mt. Nebo Scientific, Inc. and other consultants. These stations were placed in areas with the intent to provide similar study areas where data could be recorded in several disciplines including biology, hydrology and geology. These sample stations are called "team stations" in this report.

The vegetation monitoring methods of the study was principally based on those described by the USDA Forest Service for a "*Level III Riparian Area Evaluation*" (Integrated Riparian Evaluation Guide, March 1992), but does expand on those methodologies.

Qualitative and quantitative data were recorded at each sample location. Although some maintenance may be required, locations and extent of the line transects were semi-permanently marked using numbered and flagged wooden stakes and 12-inch metal nails. Photographic stations for documentation and future comparisons were established at each sample location.

RIPARIAN COMPLEX DATA SHEET

CLIENT:
COMPLEX: Riverine - Number
WATERBODY NAME:
LOCATION:
DATE:
OBSERVER(S):
QUAD NAME:
GEOLOGIC PARENT MATERIAL:
ASPECT:
VALLEY BOTTOM TYPE:
STREAM GRADIENT:
ELEVATION: .
SIZE OF COMPLEX:
SOILS INFORMATION:
ADJACENT UPLAND VEGETATION (looking downstream)
Left: Right:
VEGETATIVE DESCRIPTION (Dominance by Community Types)
SUCCESSIONAL STATUS:
APPARENT FORAGE TREND:
ESTIMATED FORAGE PRODUCTION:
BEAVER ACTIVITY:
PHOTOGRAPH TAKEN: (from right side unless otherwise stated)
LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA:
SPECIES OBSERVED:
POOL ATTRIBUTES
% area in pools:
% pool area made up of pools > 2' deep:
AQUATIC VEGETATION
% streambed with filamentous algae:
% stream margin with rooted aquatic:
BANK TYPE & VEGETATION OVERHANG
% bank length undercut (<90°):
% bank length gently sloping (>135°):
% bank length with overhanging vegetation:
BANK CONDITION (bankfull area only)
% bank length vegetated, stable:
% bank length unvegetated, stable:
% bank length vegetated, unstable:
% bank length unvegetated, unstable:
BANK STABILITY (near water line):
CHANNEL MORPHOLOGY
NOTES:

In this report, when reference is made to the left or right side of the drainage, this means “river left” or “river right”, as characterized by looking downstream.

Qualitative Data

The “Riparian Complex Data Sheet” on the previous page lists all of the qualitative data (and some of the quantitative data) that were collected at all sample stations.

Quantitative Data

As mentioned previously, USFS protocol was utilized for the study. However, to increase the level of detail, some modifications to this protocol were employed to those sample areas chosen by the team specialists (team stations). The primary reason for the modifications were twofold. First, it will provide more diverse data sets, or other ways to measure potential changes to the vegetation in the canyons. Second, there is an existing baseline data set that was recorded in 1999 for the riparian communities in the two Box Canyons. With only a couple of exceptions, the sample areas in the 1999 data set were different than the team stations of the subsequent studies. Although data began to be recorded again in 2003 and 2004 at some of the same sample locations as were used in 1999, in an attempt to maintain standardized data sets, the modifications to the protocol were not made at these stations. Some of the 1999 stations were located for the 2003 and 2004 studies so that, if necessary, they may provide worthwhile information through time that otherwise would not have been available with one baseline data set.

With the one exception to the protocol modification mentioned above, the parameters for all sample stations in the 2003, 2004, 2005, 2006 and 2008 studies were identical. The modification to the USFS protocol was in the methods that cover data were recorded. Depending on the site, three different methods were employed to measure cover. They are explained below.

Total Cover

For all the team stations, “total cover” was recorded. First, transect lines were established perpendicular to the stream channel. With a few exceptions such as constraints imposed by rock ledges or other topographical features, the transect line lengths were consistent, or 24 ft. on each side of the stream. The length of the transect lines extended far enough upslope to insure that they also included upland vegetation types (usually 3 quadrats on each side) as well as the riparian vegetation being sampled. The transect lines on each side of the stream began at the bottomland near the edge of the water, or where the riparian vegetation began. In some cases, no water was present at a given sample site. In those instances, the transect lines began where the water would normally be present (i.e. sandy or rock bottom). Water or dry channel widths were measured and added to the total length of the transects.

Regular points were placed at 3 ft. intervals on the transect lines. At these points, point quadrats

were used to record the total cover. Cover by these "hits" could include the plant species, moss, litter, bareground or rock. Therefore, total cover when the data were summarized, included 1) percent of the living cover of each plant species, 2) total living cover (vascular), 3) total living cover (nonvascular), 4) litter cover, 5) bareground cover, and 6) rock cover.

Community Type Cover

The Community Type Cover was one method to record cover in the USFS Level III protocol and was used in those additional areas that were added to the riparian study. In other words, these areas were part of the 1999 study and were added to the study *in addition to* those chosen by the team. (In a few areas, the sample locations chosen by the team and those from the 1999 study were the same – in those cases, both methods for estimating cover were employed).

At the sample locations, transects lines had previously been placed across (or perpendicular to) the stream channel. The line transects had varied lengths by design which were based on several factors. Although sometimes limited by topographical features such as sandstone cliffs, the intent was to make the transects long enough to cover the entire stream, its riparian communities, plus an additional 10 ft on each side of the stream to record the adjacent upland communities. Monitoring the total extent of the riparian plant communities including some upland community information should provide information about possible increases or decreases in the riparian communities relative to the adjacent upland communities.

Once the transect was placed, the line/point-intercept method was employed measuring the extent of each major riparian plant community. The plant communities were named by the dominant two plant species. If only one species dominated the community by a wide margin, the plant community was named by this single species. In this method, cover by each plant species is not calculated.

Green Line Cover

In addition to the methods for estimating cover described above, "Green Line" cover was also recorded at *all sample locations*. This method consisted of using a tape to measure the riparian community (Green Line) on each side of the stream and perpendicular to it. Similar to the Community Type cover described above, the dominant one or two species were listed with each measurement. Results from the Green Line method is similar to the Community Type method in that it quantifies the extent of the riparian community of each sample site. Differences are that the Green Line method separates the riparian data for each side of the stream, whereas the Community Type method provides total cover including: riparian community types, upland community types, bareground, litter, rock and stream.

Site Numbers

The sample sites that were pre-determined by the team of specialists (team stations) that will be used for studies other than those for this report were numbered accordingly and will be consistent

with those other studies (geology and hydrology). However, those additional sites that were chosen to supplement the data sets, or the subset of riparian sites that were sampled in 1999, were numbered to be consistent with those sample sites. In some cases, they are the same location. A summary to clarify the numbered sites and the cover sampling method used at each site is shown in the RESULTS section below.

RESULTS

Listed below is a summary of the sample locations, site numbers and protocol used.

Sample Site Number	Other Name or Number	USFS Level III Protocol	Cover Protocol: Green Line	Cover Protocol: Point Quadrat	Cover Protocol: Community Type
EFB-1		X	X	X	
EFB-2		X	X	X	
EFB-3		X	X	X	
EFB-4		X	X	X	
EFB-5		X	X	X	
EFB-6		X	X	X	
EFB-7		X	X	X	
EFB-8		X	X	X	
EFB-9	RE-10	X	X	X	X
EFB-10	RE-09	X	X	X	X
EFB-11		X	X	X	
EFB-S1*		X	X		X
EFB-S2*	EFB-12	X	X		X
EFB-S3*	EFB-13	X	X		X
EFB-S4*	EFB-14	X	X		X
RE-11		X	X		X
RE-12		X	X		X
RE-13		X	X		X
R-07		X	X		X
R-09		X	X		X
R-11		X	X		X
R-13		X	X		X
R-15		X	X		X
*S= Spring					

Sample results are shown for each site on the data sheets in this report. Each sheet shows all

qualitative and quantitative data recorded as well as photographic documentation.

DISCUSSION & SUMMARY

Results from monitoring the riparian communities in July 2008 in the East Fork and Main Fork of Box Canyon have been included in this report. USDA Forest Service protocol and other methods were employed to monitor the riparian areas. These methods utilized the results from qualitative data of the riparian complex such as geology, geomorphology, biology, physiognomy, soils, and channel characteristics as part of the data collection process. Quantitative data were also recorded from the plant communities. The methods used to record cover data at the team stations employed the use of point quadrats to record *Total Cover*. Additional sample stations from a previous study (1999) were also added to the sampling regime in October 2003, July 2004, October 2004, July 2005, October 2005, July 2006 and July 2008. Five of these previous sample stations were located in the East Fork of Box Canyon and five were in the Main Fork of Box Canyon. Methodologies to estimate cover (*Community Cover*) for the additional sites remained consistent with the earlier studies so that comparisons could be made later. A method referred to as the *Green Line Method* for measuring the riparian communities was also employed at all sample locations. A summary of all qualitative and quantitative data taken at each sample location are shown in the RESULTS section of this report.

As suggested in the more recent monitoring reports, upon scrutinizing the data sets for each sample period, *the Community Cover and Green Line Methods appear to be more conducive to noting changes in the riparian plant communities.*

Monitoring reports from this and previous sample periods suggest that the width of some of the riparian communities in the East Fork of Box Canyon decreased, whereas others remained relatively constant (refer to data sheets).

A summary of the findings of all riparian zones for all sample periods, including graphs, will be created following the next sample period, or October 2008.

RIPARIAN COMPLEX DATA SHEET

July 2008

CLIENT: Canyon Fuel Company

COMPLEX: Number EFB-1

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: July 28 - July 31, 2008

OBSERVER(S): P. Collins; K. Collins

QUAD NAME: Emery West, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: West

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 1^{\circ}$

ELEVATION: 8,410ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Spruce/Aspen

Right: Aspen

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data results for this information)	

SUCCESSIONAL STATUS: climax

APPARENT FORAGE TREND: stable

ESTIMATED FORAGE PRODUCTION: 700 lbs./acre (950 lbs. earlier; lots of grazing in area)

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Potentilla fruticosa</i>	<i>Ranunculus cymbalaria</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Rosa woodsii</i>	<i>Taraxacum officinale</i>	<i>Carex lanuginosa</i>
			<i>Juncus longistylis</i>
			<i>Juncus arcticus</i>
			<i>Poa pratensis</i>

POOL ATTRIBUTES (meadow, no well defined stream channel)

% area in pools: 0

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 0

% bank length with overhanging vegetation: 0

BANK CONDITION

% bank length vegetated, stable: 65 (more if I included moss)

% bank length unvegetated, stable: 35

% bank length vegetated, unstable: 0

% bank length unvegetated, unstable: 0

BANK STABILITY: relatively stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

- 1) This was a meadow area, not a stream. No water present.
- 2) Quantitative Methods: Point quadrats; sampled at 3 ft. intervals; 28+ft. transect on left side; 30 ft. transect on right side (58 ft. 8 in; includes uplands).
- 3) Vegetation was very short due to grazing in area.

DATA SUMMARIES

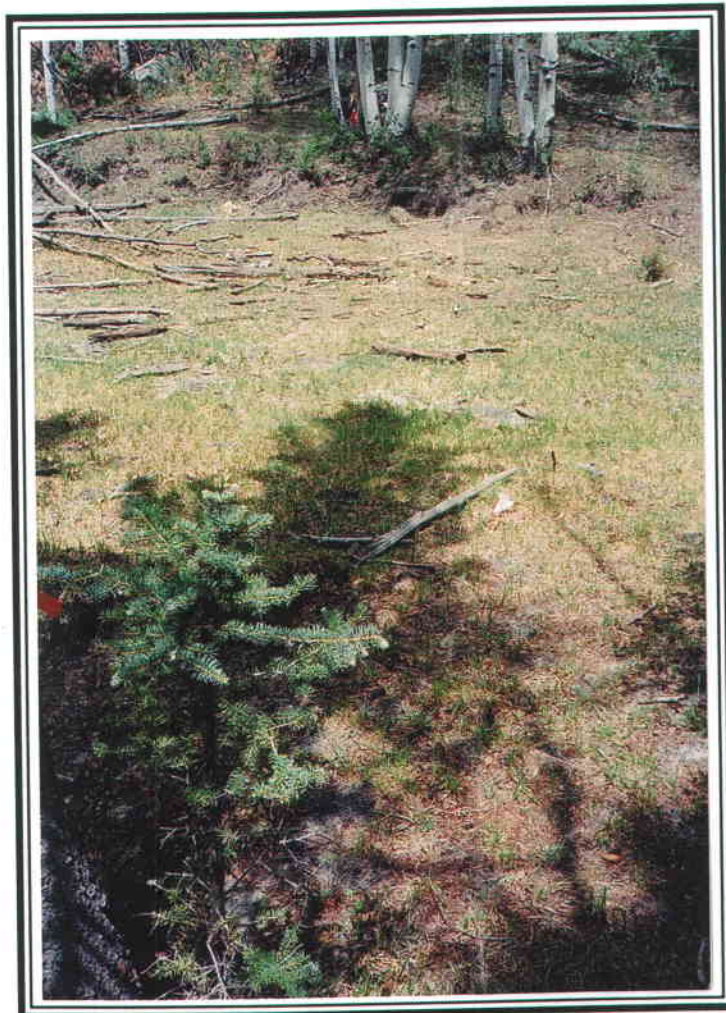
GREEN LINE WIDTH (HYDRIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-1		Left	27.0	<i>Carex lanuginosa</i> / <i>Agrostis stolonifera</i>
		Right	27.0	<i>Carex lanuginosa</i> / <i>Agrostis stolonifera</i>
		Channel	n/a	Dry (no standing water)
		Upland	4'8"	

EFB-1: Cover using point quadrats (July 2008).

COVER BY SPECIES	PERCENT
TREES & SHRUBS	
FORBS	
Taraxacum officinale	5.26
GRASSES	
Agrostis stolonifera	10.53
Carex lanuginosa	26.32
TOTAL COVER	
LIVING COVER (vascular)	42.11
WATER	0.00
MOSS	0.00
LITTER	36.84
B/G	21.05
ROCK	0.00
TOTAL	100.00

PHOTOGRAPHIC DOCUMENTATION



EFB-1

RIPARIAN COMPLEX DATA SHEET

July 2008

CLIENT: Canyon Fuel Company

COMPLEX: Number EFB-2

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: July 28 - July 31, 2008

OBSERVER(S): P. Collins; K. Collins

QUAD NAME: Emery West, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: WNW

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: ~1-2°

ELEVATION: 8,380 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Aspen/Sagebrush

Right: Aspen/Sagebrush

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: seral

APPARENT FORAGE TREND: Appear less stable

ESTIMATED FORAGE PRODUCTION: 350 lbs./ac

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, ATV, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Pinus ponderosa</i>	<i>Artemisia tridentata</i>	<i>Achillea millefolium</i>	<i>Juncus arcticus</i>
<i>Populus tremuloides</i>	<i>Potentilla fruticosa</i>	<i>Aster sp.</i>	<i>Agrostis stolonifera</i>
		<i>Potentilla sp.</i>	<i>Poa pratensis</i>
		<i>Taraxacum officinale</i>	<i>Poa secunda</i>
		<i>Campanula parryi</i>	

POOL ATTRIBUTES (meadow, no well defined stream channel)

% area in pools: 0

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 80

% bank length with overhanging vegetation: 0

BANK CONDITION

% bank length vegetated, stable: 50

% bank length unvegetated, stable: 35

% bank length vegetated, unstable: 0

% bank length unvegetated, unstable: 15

BANK STABILITY: stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) This was a meadow area, not a stream, but channel was beginning to develop. 2) Quantitative Methods: Point quadrats; sampled at 3 ft. intervals; 24 ft. transect on left side; 25 ft. transect on right side (48 ft; includes uplands).

3) Site was dry. *More* bareground than previous samples.

4) Meadow was dominated by Kentucky bluegrass; wetter areas of site were dominated by redtop and wiregrass.

5) Site seemed drier this period compared to last sample period; more bare ground present due to grazing and flooding.

DATA SUMMARIES

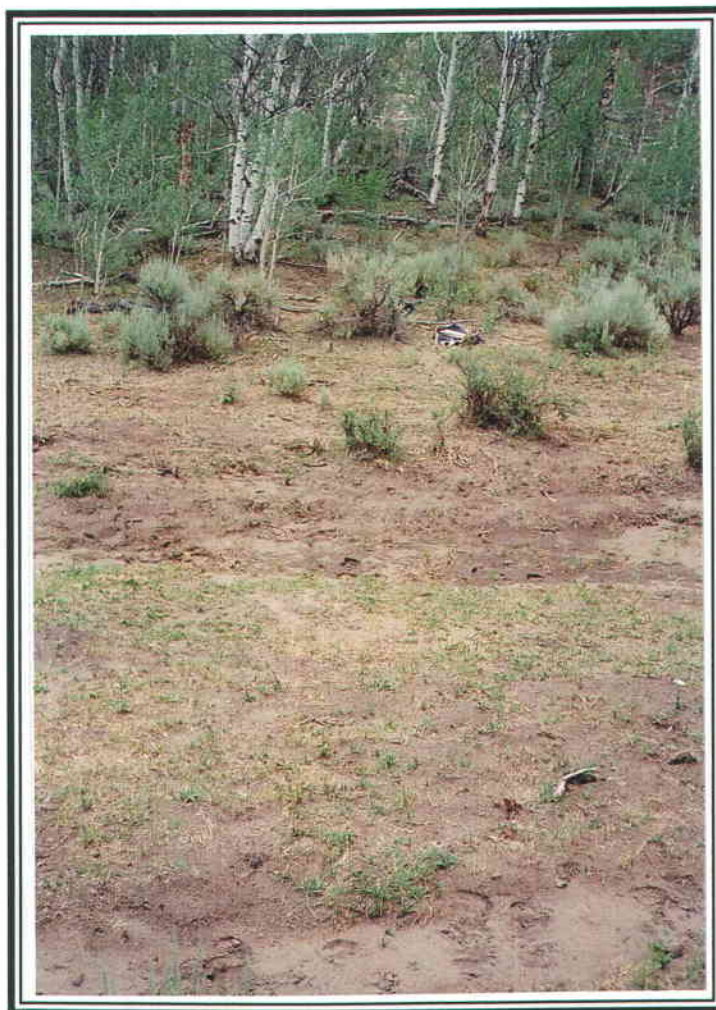
GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-2		Left	15.0	<i>Agrostis stolonifera/Juncus arcticus/Taraxacum officinale</i>
		Right	16.0	<i>Agrostis stolonifera/Juncus arcticus/Taraxacum officinale</i>
		Channel	17.0	Upland

EFB-2: Cover using point quadrats (July 2008)

COVER BY SPECIES	PERCENT
TREES & SHRUBS	
<i>Artemisia tridentata</i>	6.25
FORBS	
<i>Achillea millefolium</i>	6.25
GRASSES	
<i>Poa pratensis</i>	18.75
TOTAL COVER	
LIVING COVER (vascular)	31.25
STREAM	0.00
MOSS	0.00
LITTER	18.75
B/G	50.00
ROCK	0.00
TOTAL	100.00

PHOTOGRAPHIC DOCUMENTATION



EFB-2

RIPARIAN COMPLEX DATA SHEET

July 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-3

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: July 28 - July 31, 2008

OBSERVER(S): P. Collins; K. Collins

QUAD NAME: Emery West, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: NW

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 2^\circ$

ELEVATION: 8,360 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Aspen

Right: Aspen/Ponderosa Pine

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: seral to climax (but recent years' upper bank movement influences status).

APPARENT FORAGE TREND: unstable

ESTIMATED FORAGE PRODUCTION: 300 lbs./ac

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Pinus ponderosa</i>	<i>Artemisia tridentata</i>	<i>Equisetum arvense</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>		<i>Lepidium latifolia</i>	<i>Carex lanuginosa</i>
		<i>Taraxacum officinale</i>	<i>Juncus arcticus</i>
		<i>Eriogonum sp.</i>	<i>Poa fendleriana</i>
		<i>Lupinus sp.</i>	<i>Poa pratensis</i>
		<i>Artemisia dracunculus</i>	
		<i>Penstemon sp.</i>	

POOL ATTRIBUTES

% area in pools: n/a (no water in the channel at this location)

% pool area made up of pools > 2' deep: n/a (no water in the channel at this location)

AQUATIC VEGETATION

% streambed with filamentous algae: n/a (no water in the channel at this location)

% stream margin with rooted aquatic: n/a (no water in the channel at this location)

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°):

% bank length with overhanging vegetation: 0

BANK CONDITION

% bank length vegetated, stable: 60

% bank length unvegetated, stable: 20

% bank length vegetated, unstable: 10

% bank length unvegetated, unstable: 10

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) Quantitative Methods: Point quadrats; sampled at 3 ft. intervals; 24 ft. transect on left side; 24 ft. transect on right side. (48 ft; includes uplands).

2) Grazed by cattle this year.

- 3) Dry, no water.
- 4) Cattle trail in left side of riparian vegetation may influence green line measurements.
- 5) Erosion occurring on right side from overland surface water perpendicular to stream channel.
- 6) There were signs of recent flooding; sandy banks were quite unstable.
- 7) Riparian spp. seemed to be more prevalent above what I measured as the stream riparian plants. In other words, they were on side areas and maybe were uninfluenced by bottomland riparian water zone.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-3		Left	4.0	<i>Agrostis stolonifera</i> / <i>Carex lanuginosa</i>
		Right	3.0	<i>Agrostis stolonifera</i> / <i>Carex lanuginosa</i>
		Channel	n/a	Dry, but vegetated

EFB-3: Cover using point quadrats (July 2008).

COVER BY SPECIES	PERCENT
TREES & SHRUBS	
FORBS	
<i>Artemisia dracunculus</i>	6.25
<i>Lupinus sp.</i>	6.25
GRASSES	
<i>Carex lanuginosa</i>	6.25
<i>Poa pratensis</i>	18.75
TOTAL COVER	
LIVING COVER (vascular)	
WATER	37.50
MOSS	0.00
LITTER	12.50
B/G	43.75
ROCK	6.25
TOTAL	100.00

PHOTOGRAPHIC DOCUMENTATION



EFB-3

RIPARIAN COMPLEX DATA SHEET
July 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-4

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: July 28 - July 31, 2008

OBSERVER(S): P. Collins; K. Collins

QUAD NAME: Emery West, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: N

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 3^{\circ}$

ELEVATION: 8,355 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Ponderosa Pine/Aspen

Right: Aspen/Ponderosa Pine

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: seral (but recent years' upper bank movement could influence status).

APPARENT FORAGE TREND: Decreasing

ESTIMATED FORAGE PRODUCTION: 100 lbs./ac

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Artemisia tridentata</i>	<i>Antennaria sp.</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Chrysothamnus nauseosus</i>	<i>Equisetum arvense</i>	<i>Juncus arcticus</i>
<i>Pinus ponderosa</i>	<i>Potentilla fruticosa</i>		<i>Poa fendleriana</i>
	<i>Rosa woodsii</i>		<i>Poa pratensis</i>
			<i>Poa secunda</i>
			<i>Carex lanuginosa</i>

POOL ATTRIBUTES

% area in pools: Dry

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 5 (dry trail)

% bank length with overhanging vegetation: 5

BANK CONDITION

% bank length vegetated, stable: 20

% bank length unvegetated, stable: 10

% bank length vegetated, unstable: 5

% bank length unvegetated, unstable: 65

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) Quantitative Methods: Point quadrats; sampled at 3 ft. intervals; 24 ft. transect on left side; 24 ft. transect on right side (48 ft; includes uplands).

2) No water was present at site, but in July 2006 a very large storm event forced me to leave the site. Flooding and severe bank erosion occurred at that time. I later learned the storm event was >1.20" of precipitation in less than 1 hour. Also, another 1.79" evidently occurred one day after I left the area.

- 3) No grazing by cattle observed for this sample period here.
- 4) Recent flooding evidence; lots of sand movement downstream and on side banks.

DATA SUMMARIES

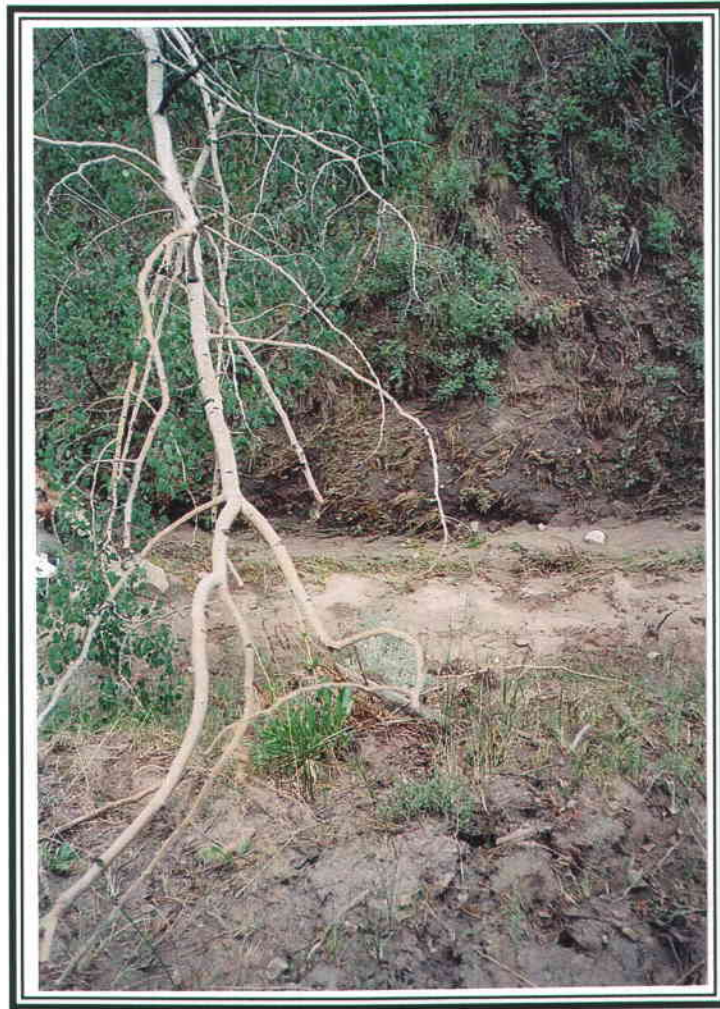
GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-4		Left	3.0	<i>Agrostis stolonifera</i> / <i>Carex lanuginosa</i> / <i>Juncus arcticus</i>
		Right	4.0	<i>Agrostis stolonifera</i> / <i>Carex lanuginosa</i> / <i>Juncus arcticus</i>
		Channel		above includes vegetated dry channel

EFB-4: Cover using point quadrats (July 2008).

COVER BY SPECIES	PERCENT
TREES & SHRUBS	
<i>Populus tremuloides</i>	6.25
<i>Rosa woodsii</i>	6.25
FORBS	
<i>Equisetum arvense</i>	
GRASSES	
<i>Carex lanuginosa</i>	6.25
<i>Poa pratensis</i>	12.50
<i>Poa secunda</i>	18.75
TOTAL COVER	
LIVING COVER (vascular)	50.00
WATER	0.00
MOSS	0.00
LITTER	18.75
B/G	25.00
ROCK	6.25
TOTAL	100.00

PHOTOGRAPHIC DOCUMENTATION



EFB-4

RIPARIAN COMPLEX DATA SHEET

July 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-5

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: July 28 - July 31, 2008

OBSERVER(S): P. Collins; K. Collins

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: N

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 2^\circ$

ELEVATION: 8,320 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Aspen

Right: Ponderosa Pine/Aspen

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: climax (but recent years' upper bank movement could influence status).

APPARENT FORAGE TREND: moderately unstable

ESTIMATED FORAGE PRODUCTION: 100 lbs./ac

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Artemisia tridentata</i>	<i>Antennaria</i> sp.	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Potentilla fruticosa</i>	<i>Lupinus</i> sp.	<i>P. secunda</i>
<i>Pinus ponderosa</i>	<i>Rosa woodsii</i>	<i>Castilleja exilis</i>	<i>P. pratensis</i>
	<i>Salix exigua</i>	<i>Penstemon</i> sp.	<i>Stipa hymenoides</i>
	<i>Symphoricarpos oreophilus</i>		<i>Bouteloua gracilis</i>
	<i>Chrysothamnus nauseosus</i>		

POOL ATTRIBUTES

% area in pools: n/a (no water in this area)

% pool area made up of pools > 2' deep: n/a (no water in this area)

AQUATIC VEGETATION

% streambed with filamentous algae: n/a (no water in this area)

% stream margin with rooted aquatic: n/a (no water in this area)

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 0 (but close to 135°)

% bank length with overhanging vegetation: 1%

BANK CONDITION

% bank length vegetated, stable: 15

% bank length unvegetated, stable: 0

% bank length vegetated, unstable: 10

% bank length unvegetated, unstable: 75

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

- 1) Side slopes (above bankfull) were very sandy and unstable.
- 2) Quantitative Methods: Point quadrats; sampled at 3 ft. intervals; 24 ft. transect on left side; 24 ft. transect on right side (48 ft; includes uplands).
- 3) No water in channel in this location; recent flooding evident.

4) No cattle grazing signs observed this sample period.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-5		Left	2.0	<i>Agrostis stolonifera</i> / <i>Salix exigua</i>
		Right	3.0	<i>Agrostis stolonifera</i>
		Channel	3.0	Dry, sandy

EFB-5 Cover using point quadrats (July 2008).

COVER BY SPECIES	PERCENT
TREES & SHRUBS	
FORBS	
<i>Artemisia dracunculus</i>	6.25
<i>Lupinus argenteus</i>	12.50
GRASSES	
<i>Agrostis stolonifera</i>	12.50
TOTAL COVER	
LIVING COVER (vascular)	31.25
WATER	0.00
MOSS	0.00
LITTER	12.50
B/G	50.00
ROCK	6.25
TOTAL	100.00

PHOTOGRAPHIC DOCUMENTATION



EFB-5

RIPARIAN COMPLEX DATA SHEET

July 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-6

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: July 28 - July 31, 2008

OBSERVER(S): P. Collins; K. Collins

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: N

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 2^\circ$

ELEVATION: 8,280 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Aspen/Ponderosa Pine

Right: Pinus ponderosa/Aspen

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: Seral (but recent years' upper bank movement could influence status).

APPARENT FORAGE TREND: decreasing

ESTIMATED FORAGE PRODUCTION: 100 lbs./ac

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Amelanchier utahensis</i>	<i>Taraxacum officinale</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Potentilla fruticosa</i>	<i>Antennaria sp.</i>	<i>Bromus carinatus</i>
<i>Pinus ponderosa</i>	<i>Symphoricarpos oreophilus</i>	<i>Aster sp.</i>	<i>Juncus arcticus</i>
<i>Populus fremontii</i>	<i>Artemisia tridentata</i>	<i>Gilia aggregata</i>	<i>Poa fendleriana</i>
		<i>Artemisia ludoviciana</i>	<i>Elymus trachycaulus</i>
			<i>Poa pratensis</i>

POOL ATTRIBUTES

% area in pools: Dry

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 50

% bank length gently sloping (>135°): (trail)

% bank length with overhanging vegetation: 10

BANK CONDITION

% bank length vegetated, stable: 15

% bank length unvegetated, stable: 35

% bank length vegetated, unstable: 10

% bank length unvegetated, unstable: 40

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable):
stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) Side slope banks above bankfull unstable

2) Quantitative Methods: Point quadrats; sampled at 3 ft. intervals; 24 ft. transect on left side; 24 ft. transect on right side (48 ft; includes uplands).

3) Little or no grazing by cattle this year. Dry this July, and no water was just downstream 50'-70' like in October 2007.

- 4) Lots of bank movement.
- 5) The bottom appeared more sandy and wider than before.

DATA SUMMARIES

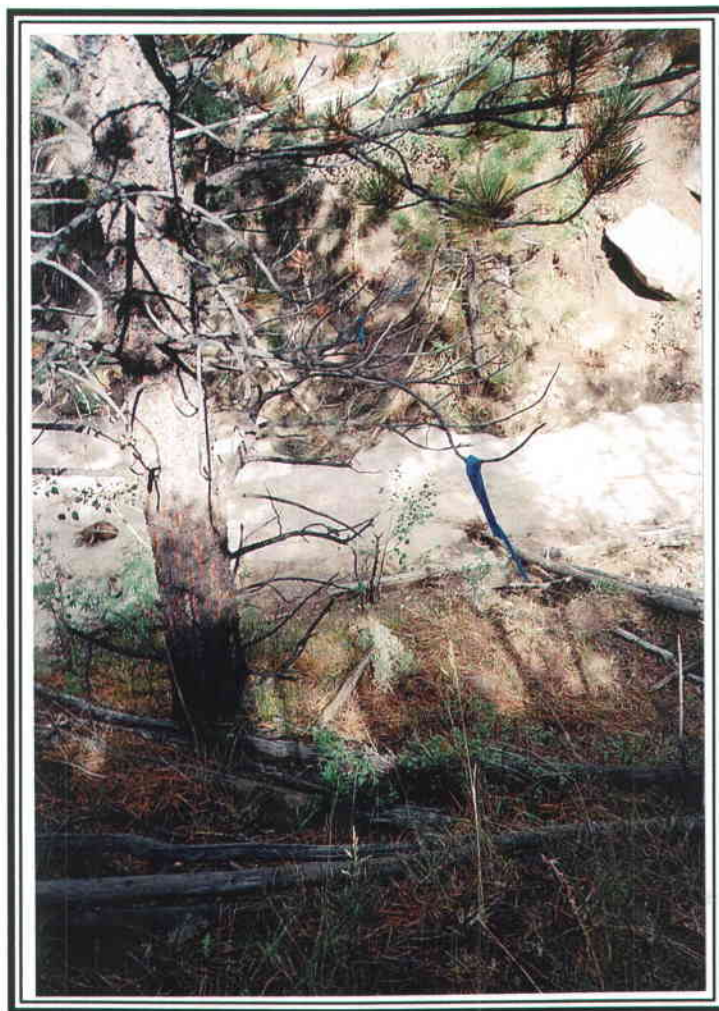
GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-6		Left	1.0	<i>Agrostis stolonifera</i>
		Right	1.5	<i>Agrostis stolonifera</i>
		Channel	7.0	Dry

EFB-6 Cover using point quadrats (July 2008).

COVER BY SPECIES	PERCENT
TREES & SHRUBS	
<i>Populus fremontii</i>	6.25
<i>Populus tremuloides</i>	6.25
FORBS	
<i>Lupinus argenteus</i>	6.25
<i>Taraxacum officinale</i>	6.25
GRASSES	
<i>Poa pratensis</i>	18.75
TOTAL COVER	
LIVING COVER (vascular)	43.75
WATER	0.00
MOSS	0.00
LITTER	12.50
B/G	37.50
ROCK	6.25
TOTAL	100.00

PHOTOGRAPHIC DOCUMENTATION



EFB-6

RIPARIAN COMPLEX DATA SHEET
July 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-7

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: July 28 - July 31, 2008

OBSERVER(S): P. Collins; K. Collins

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: NNW

VALLEY BOTTOM TYPE: I or II

STREAM GRADIENT: $\sim 2^{\circ}$

ELEVATION: 8,270 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Aspen/Spruce

Right: Aspen/Spruce

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: seral

APPARENT FORAGE TREND: Unstable

ESTIMATED FORAGE PRODUCTION: 0 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Juniperus communis</i>	<i>Aster sp.</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Symphoricarpos oreophilus</i>	<i>Artemisia dracunculus</i>	<i>Poa fendleriana</i>
<i>Rosa woodsii</i>		<i>Castilleja sp.</i>	

POOL ATTRIBUTES

- % area in pools: no water
- % pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

- % streambed with filamentous algae: 0
- % stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

- % bank length undercut (<90°): 0
- % bank length gently sloping (>135°): 100 until steep, unstable, upper banks, then 0.
- % bank length with overhanging vegetation: 2

BANK CONDITION

- % bank length vegetated, stable: 50 undercut rocks
- % bank length unvegetated, stable: 0
- % bank length vegetated, unstable: 0 (above riparian zone)
- % bank length unvegetated, unstable: 0

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

- 1) Water not was present.
- 2) Quantitative Methods: Point quadrats; sampled at 3 ft. intervals; 24 ft. transect on left side; 24 ft. transect on right side (48 ft; includes uplands).
- 3) This was a rock channel now.
- 4) Little or no grazing in this area.
- 5) Much side slope movement on right and left sides.

- 6) This area seemed to have much more bedrock exposed with less soil on left bank along the riparian channel. There was not much of a riparian zone at this site. This may be the result of the several past flood events.
- 7) Aspens have fallen since early data (see photos).
- 8) 11 ft of stream channel (rock); soil and riparian communities appear to have moved by flooding.
- 9) Water was not present this sample period here, but it was running 3 ft downstream. There was no running water above this sample point - only puddles.

DATA SUMMARIES

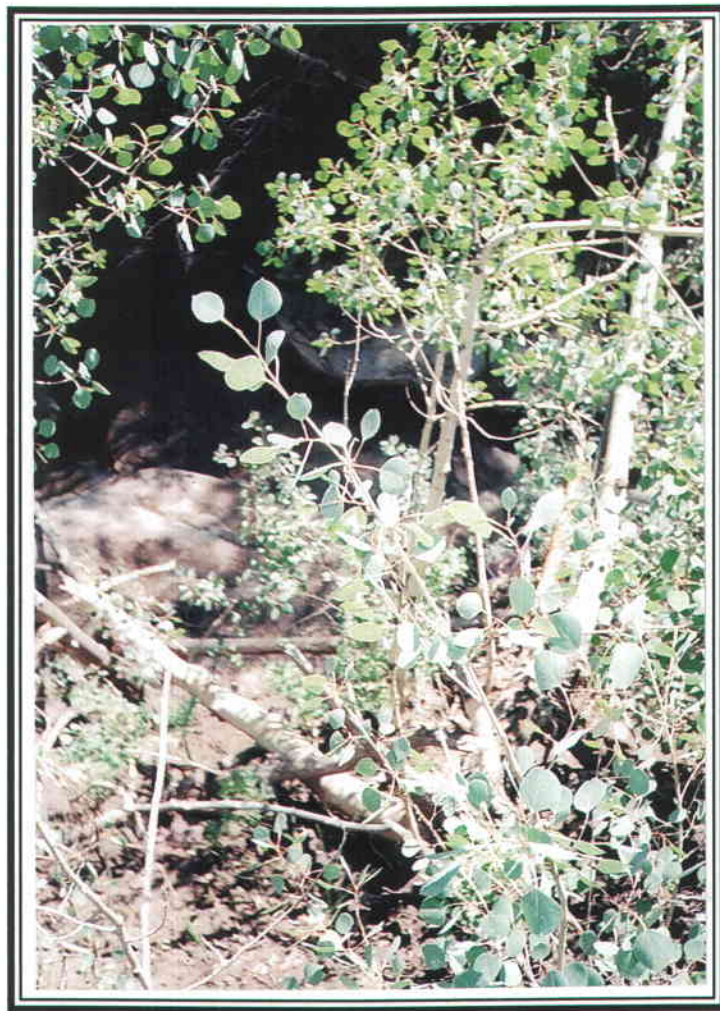
GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-7		Left	0	<i>Agrostis stolonifera</i>
		Right	0	<i>Agrostis stolonifera</i>
		Channel Water	11.0	Rock Water

EFB-7 Cover using point quadrats (July 2008).

COVER BY SPECIES	PERCENT
TREES & SHRUBS	
<i>Populus tremuloides</i>	6.25
<i>Symphoricarpos oreophilus</i>	6.25
FORBS	
GRASSES	
<i>Poa pratensis</i>	6.25
TOTAL COVER	
LIVING COVER (vascular)	18.75
WATER	0.00
MOSS	0.00
LITTER	18.75
B/G	37.50
ROCK	25.00
TOTAL	100.00

PHOTOGRAPHIC DOCUMENTATION



EFB-7

RIPARIAN COMPLEX DATA SHEET

July 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-8

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: July 28 - July 31, 2008

OBSERVER(S): P. Collins; K. Collins

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: NNW

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 2^{\circ}$

ELEVATION: 8,265 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Spruce/Aspen

Right: Aspen/Spruce

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: climax (but recent years' upper bank movement could influence status).

APPARENT FORAGE TREND: Unstable

ESTIMATED FORAGE PRODUCTION: 0 lbs./ac. in riparian zone.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Symphoricarpos oreophilus</i>	<i>Ranunculus cymbalaria</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>		<i>Achillea millefolium</i>	<i>Poa fendleriana</i>
<i>Pinus ponderosa</i>		<i>Penstemon</i> sp.	<i>P. pratensis</i>
		<i>Antennaria</i> sp.	
		<i>Equisetum arvensis</i>	
		<i>Potentilla</i> sp.	

POOL ATTRIBUTES

% area in pools: 75

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 50, but only sandy sediments.

% bank length with overhanging vegetation: 10

BANK CONDITION (riparian channel)

% bank length vegetated, stable: 0

% bank length unvegetated, stable: 50

% bank length vegetated, unstable: 0

% bank length unvegetated, unstable: 50

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

- 1) Beginning to see more blue spruce and less ponderosa pine in uplands in this area.
- 2) Quantitative Methods: This is a difficult area to monitor because there is a spring on the right side with water flowing from it. The information above is for the main channel.

- 3) For the point quads, the transect crossed the spring community too (transect total = 56 ft; channel erosion increased length from 54 ft). *I did not count the "island" between the two as riparian* (but I may have previously). For both separate data, see the Green Line method below.
- 4) There were severe flooding impacts here in the July 2006 flood. The bank was down cut ± 3 ft lower than the previous elevations. There was a great deal of debris in the area. The small green conifer in the area was downed (compare photographs with previous sample periods). Riparian communities have been impacted by the flooding.
- 5) No cattle sign this year.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-8 Main Channel		Left	0	<i>Equisetum arvensis/Agrostis stolonifera</i>
		Right	0	<i>Equisetum arvense</i>
		Channel	6.0	Water
EFB-8 Spring Channel		Left	1.0	<i>Agrostis stolonifera</i>
		Right	0.0	<i>Agrostis stolonifera</i>
		Channel	4.0 1.0	Mud Water

EFB-8 Cover using point quadrats (July 2008).

COVER BY SPECIES	PERCENT
TREES & SHRUBS	
<i>Picea pungens</i>	5.56
<i>Populus tremuloides</i>	5.56
FORBS	
GRASSES	
<i>Poa pratensis</i>	5.56
TOTAL COVER	
LIVING COVER (vascular)	16.67
WATER	16.67
MOSS	0.00
LITTER	22.22
B/G	38.89
ROCK	5.56
TOTAL	100.00

PHOTOGRAPHIC DOCUMENTATION



EFB-8

RIPARIAN COMPLEX DATA SHEET
July 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-9 (RE-10)

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: July 28 - July 31, 2008

OBSERVER(S): P. Collins; K. Collins

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss/Blackhawk Fm

ASPECT: W

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 3^\circ$

ELEVATION: 8,240 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Aspen

Right: Spruce/Aspen

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: Seral (recent years' upper bank movement has influenced status).

APPARENT FORAGE TREND: no riparian vegetation present

ESTIMATED FORAGE PRODUCTION: 0

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Ribes</i> sp.	<i>Equisetum arvensis</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Rosa woodsii</i>		
<i>Salix amygdaloides</i>	<i>Symphoricarpos oreophilus</i>		

POOL ATTRIBUTES

% area in pools: 50

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 50

% bank length gently sloping (>135°): 0

% bank length with overhanging vegetation: 35

BANK CONDITION

% bank length vegetated, stable: 0

% bank length unvegetated, stable: 50

% bank length vegetated, unstable: 0

% bank length unvegetated, unstable: 50

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable (left side)/unstable (right side)

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

- 1) Bank cut on right and left sides.
- 2) Quantitative Methods: Point quadrats; sampled at 3 ft. intervals for 38 ft.(see below). In addition, the USDA Forest Service Protocol for Level III was employed by measuring the plant communities using the line intercept method.
- 3) Little or no grazing by cattle this year.
- 4) For point quadrats we had different transect lengths: Oct 03 (50 ft), July 04 (50 ft), Oct 04 (32 ft or 38 ft); subsequent measurements (38'). This is probably because there were two transects marked in the field because we also utilized transects from our 1999 study which were different than the one's marked by the team for the more recent studies. *Note that comparisons of these data can be confusing because pt. quad transects were sometimes different than line transects.*

4) Floods mentioned earlier basically eliminated the riparian zone at this site.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-9	RE-10	Left	0	<i>Equisetum arvense</i>
		Right	0	<i>Equisetum arvense</i>
		Channel	1.0 4.0	Water Rock

RE-10 (EFB-9) Cover using point quadrats (July 2008).

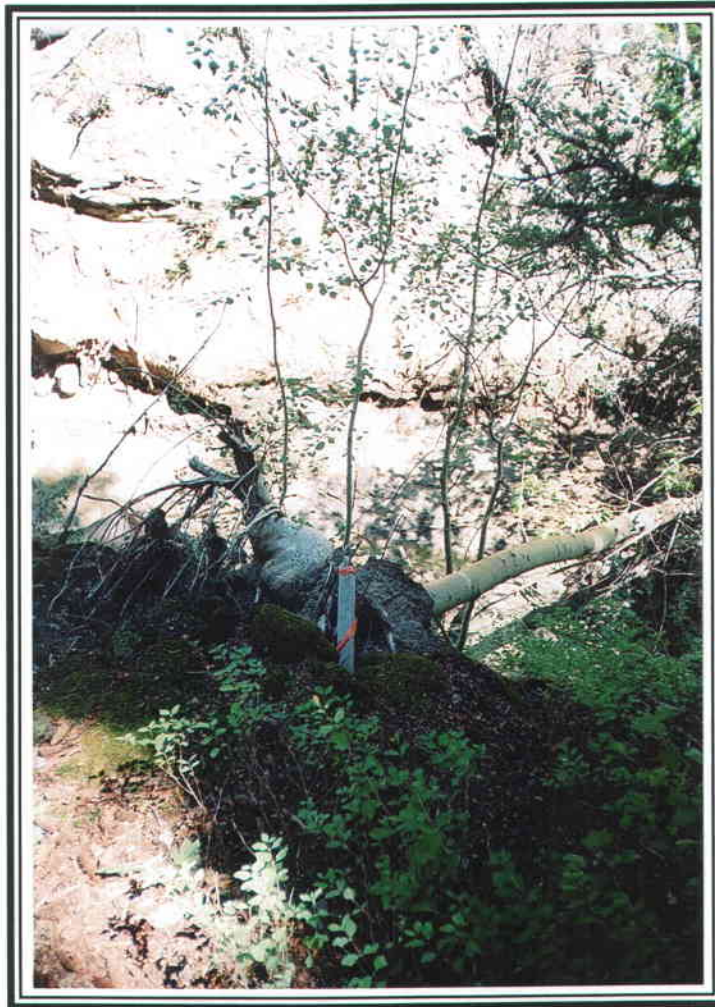
COVER BY SPECIES	PERCENT
TREES & SHRUBS	
<i>Populus tremuloides</i>	8.33
FORBS	
GRASSES	
TOTAL COVER	
LIVING COVER (vascular)	8.33
WATER	0.00
MOSS	8.33
LITTER	25.00
B/G	16.67
ROCK	41.67
TOTAL	100.00

EFB-09 (RE-10): Cover by community types in Box Canyons (July 2008)

USDA Forest Service Protocol (1992)

	Cover (ft)
UPLAND VEGETATION	
<i>Populus tremuloides/Picea pungens</i>	21.00
<i>Populus tremuloides/Rosa woodsii</i>	8.00
RIPARIAN VEGETATION	
<i>Equisetum arvensis</i>	0.00
TOTAL COVER (Upland Species)	29.00
TOTAL COVER (Riparian Species)	0.00
BAREGROUND/LITTER	4.00
ROCK	4.00
WATER/MUD/DRY CHANNEL	1.00
Moss	0.00
TOTAL COVER	38.00

PHOTOGRAPHIC DOCUMENTATION



EFB-9 (RE-10)

RIPARIAN COMPLEX DATA SHEET

July 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-10 (RE-09)

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: July 28 - July 31, 2008

OBSERVER(S): P. Collins; K. Collins

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Blackhawk

ASPECT: N

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 3^{\circ}$

ELEVATION: 8,120 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%

MORE SOILS INFORMATION:

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Spruce

Right: Spruce/Aspen

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: Unstable.

APPARENT FORAGE TREND: Decreasing

ESTIMATED FORAGE PRODUCTION: 50 lbs./ac

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Salix sp.</i>	<i>Ranunculus cymbalaria</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Rosa woodsii</i>	<i>Geranium richardsonii</i>	<i>Poa pratensis</i>
<i>Betula occidentalis</i>		<i>Equisetum arvense</i>	
		<i>Epilobium angustifolium</i>	

POOL ATTRIBUTES

% area in pools: 50

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 10

% bank length gently sloping (>135°): 50

% bank length with overhanging vegetation: 10

BANK CONDITION

% bank length vegetated, stable: 10

% bank length unvegetated, stable: 30

% bank length vegetated, unstable: 10

% bank length unvegetated, unstable: 50

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

- 1) Just beginning to see river birch in this area.
- 2) Quantitative Methods: There were two transect lines here because of the older (1999) study. One was 28 ft (from 1999) and one was 36 ft (team study). For point quadrats for Oct 2005, we sampled at 3 ft. intervals for the 28 ft transect line. I also sampled on 36 ft line (left in raw data). Regarding the two pt. quad transect lines (28 ft and 36 ft) for July 2006 and Oct 2006, we also sampled the 36 ft line in July 2007.
In addition, the USDA Forest Service Protocol for Level III was employed by measuring the plant communities using the line intercept method (I used a 36 ft transect line in Oct 2005 and July 2006 which was *not consistent with July 2005*).
- 3) Right hillside suggests (by presence of horsetail) that there is probably a lot of soil moisture in the spring and early summer. No water in hillside observed
- 4) Water at site; waterfall is above this station.
- 5) Photo taken from left side.
- 6) Negligible grazing by cattle this year.
- 7) There was lots of bareground that I counted in the upland community.
- 8) There were some small live blue spruce trees downed due to flooding and side slope movement.
- 9) Very unstable area at this time.
- 10) I believe this is one of D. Shiozawa's macroinvertebrate sampling sites.
- 11) The flood in July 2006 took most of the riparian zone on the left side.
- 12) No riparian community observed; there were some roots observed from the hillside vegetation.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-10	RE-09	Left	0.0	<i>Equisetum arvense</i> / <i>Geranium richardsonii</i>
		Right	0.0	<i>Equisetum arvense</i>
		Channel	2.0 5.0	Water Rock

RE-9 (EFB-10) Cover using point quadrats (July 2008).

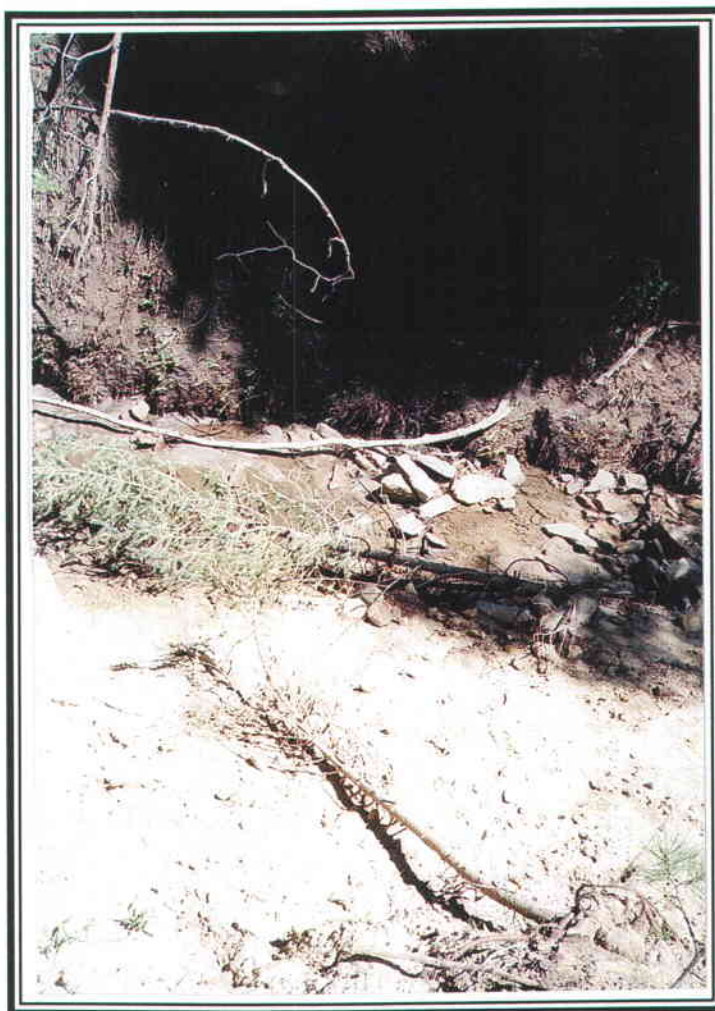
COVER BY SPECIES	PERCENT
TREES & SHRUBS	
FORBS	
GRASSES	
TOTAL COVER	
LIVING COVER (vascular)	0.00
WATER	8.33
MOSS	0.00
LITTER	8.33
B/G	50.00
ROCK	33.33
TOTAL	100.00

RE-09 (EFB-10): Cover by community types in Box Canyons (July 2008)

USDA Forest Service Protocol (1992)

	Cover (ft)
UPLAND VEGETATION	
<i>Populus tremuloides</i>	29.00
RIPARIAN VEGETATION	
<i>Geranium richardsonii/Equisetum arvense</i>	0.00
TOTAL COVER (Upland Species)	29.00
TOTAL COVER (Riparian Species)	0.00
BAREGROUND/LITTER	0.00
ROCK	5.00
WATER/MUD/DRY CHANNEL	2.00
MOSS	0.00
TOTAL COVER	36.00

PHOTOGRAPHIC DOCUMENTATION



EFB-10 (RE-09)

RIPARIAN COMPLEX DATA SHEET

July 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-11

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: July 28 - July 31, 2008

OBSERVER(S): P. Collins; K. Collins

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Blackhawk Fm

ASPECT: NW

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: ~3°

ELEVATION: 8,120 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%

MORE SOILS INFORMATION:

- Soil Map Unit No. 20
- Family: Strych
- Composition:
 - Strych Family Soils: 30 %
 - Pathead Family Soils: 30%
 - Podo Family Soils: 15%
 - Rubbleland: 15%
 - Contrasting inclusions of rock outcrops, and finer textured soils: 10%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Spruce/Aspen

Right: Spruce/Aspen

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: Unstable due to recent flooding.

APPARENT FORAGE TREND: Decreasing

ESTIMATED FORAGE PRODUCTION: 50 lbs/ac. (including woody species)

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Pachystima myrsinites</i>	<i>Cirsium sp.</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Symphoricarpos oreophilus</i>	<i>Geranium richardsonii</i>	<i>Juncus longistylis</i>
<i>Salix sp.</i>		<i>Equisetum arvense</i>	<i>Poa fendleriana</i>
<i>Cornus sericea</i>			
<i>Betula occidentalis</i>			

POOL ATTRIBUTES

% area in pools: 70

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 0

% bank length with overhanging vegetation: 20

BANK CONDITION

% bank length vegetated, stable: 5

% bank length unvegetated, stable: 45

% bank length vegetated, unstable: 5

% bank length unvegetated, unstable: 45

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

- 1) This site is just below the confluence of a spring (EFB-S1)
- 2) Quantitative Methods: Point quadrats; sampled at 3 ft. intervals on a 45 ft transect line.
- 3) Little or no grazing by cattle this year.
- 4) Flood took down or pushed over mature trees just upstream from sample site including river birch, willow, and dogwood (photographs taken for files in July and October 2006).
- 5) Most of the riparian zone was eliminated from flooding.
- 6) Did not find right stake so we put one at 45'.
- 7) There was more water cover this year

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-11		Left	1.0	<i>Agrostis stolonifera</i>
		Right	0.5	<i>Agrostis stolonifera</i>
		Channel	4.5 2.5	Water Rock

EFB-11 Cover using point quadrats (July 2008).

COVER BY SPECIES	PERCENT
TREES & SHRUBS	
FORBS	
<i>Equisetum arvense</i>	6.67
<i>Cirsium</i> sp.	6.67
<i>Geranium richardsonii</i>	6.67
GRASSES	
TOTAL COVER	
LIVING COVER (vascular)	20.00
WATER	6.67
MOSS	6.67
LITTER	26.67
B/G	20.00
ROCK	20.00
TOTAL	100.00

PHOTOGRAPHIC DOCUMENTATION



EFB-11

RIPARIAN COMPLEX DATA SHEET

July 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-S1

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: July 28 - July 31, 2008

OBSERVER(S): P. Collins; K. Collins

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Blackhawk Fm

ASPECT: W

VALLEY BOTTOM TYPE: II

STREAM (SLOPE) GRADIENT: $\sim 28^{\circ}$

ELEVATION: 8,120 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 20
- Family: Strych
- Composition:
 - Strych Family Soils: 30 %
 - Pathead Family Soils: 30%
 - Podo Family Soils: 15%
 - Rubbleland: 15%
 - Contrasting inclusions of rock outcrops, and finer textured soils: 10%

MORE SOILS INFORMATION:

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Spruce/Aspen

Right: Spruce/Aspen

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: unstable

APPARENT FORAGE TREND: stable

ESTIMATED FORAGE PRODUCTION: 400 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Salix</i> sp.	<i>Equisetum arvense</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Symphoricarpos oreophilus</i>	<i>Ranunculus cymbalaria</i>	<i>Carex lanuginosa</i>
	<i>Rosa woodsii</i>	<i>Aster</i> sp.	<i>Elymus trachycaulus</i>
	<i>Lonicera involucrata</i>	<i>Geranium richardsonii</i>	<i>Juncus arcticus</i>
	<i>Betula occidentalis</i>		<i>Bromus carinatus</i>

POOL ATTRIBUTES

% area in pools: 15

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 30 (of wet area studied)

% bank length with overhanging vegetation: 10 (but increases above this area)

BANK CONDITION

% bank length vegetated, stable: 50

% bank length unvegetated, stable: 30

% bank length vegetated, unstable: 0

% bank length unvegetated, unstable: 20 (left bank above green)

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) A spring area, it is located about 50 ft. above confluence with the main channel of East Fork of Box Canyon.

2) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method.

- 3) Original stakes were gone. I put blue flagging and made a 37 ft transect line in Oct 2005; I used this line for the remainder of the sample periods.
- 4) Water in spring seems to be increasing compared to the last two sample periods. The spring water seems to have increased its flow. Good flow from spring in July 2008. Vegetation cover seemed to have decreased somewhat.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-S1		Left	7.0	<i>Equisetum arvense/Ranunculus cymbalaria</i>
		Right	4.0	<i>Equisetum arvense/Ranunculus cymbalaria</i>
		Channel	2.0	Water

EFB-S1: Cover by community types in Box Canyons (July 2008)

USDA Forest Service Protocol (1992)

	Cover (ft)
UPLAND VEGETATION	
<i>Aster/Bareground</i>	15.00
<i>Bromus carinatus</i>	9.00
RIPARIAN VEGETATION	
<i>Geranium richardsonii/Equisetum arvense</i>	3.00
<i>Ranunculus cymbalaria/Equisetum arvensis</i>	8.00
TOTAL COVER (Upland Species)	24.00
TOTAL COVER (Riparian Species)	11.00
Bareground/LITTER	0.00
ROCK	0.00
WATER/MUD/DRY CHANNEL	2.00
MOSS	0.00
TOTAL COVER	37.00

PHOTOGRAPHIC DOCUMENTATION



EFB-S1

RIPARIAN COMPLEX DATA SHEET

July 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-S2 (EFB-12)

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: July 28 - July 31, 2008

OBSERVER(S): P. Collins; K. Collins

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss/Blackhawk Fm

ASPECT: W

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: ~30°

ELEVATION: 8,200 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%

MORE SOILS INFORMATION:

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Picea pungens

Right: Picea pungens

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: Not climax, unstable.

APPARENT FORAGE TREND: Unstable

ESTIMATED FORAGE PRODUCTION: 500 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Juniperus communis</i>	<i>Ranunculus cymbalaria</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>		<i>Equisetum arvense</i>	<i>Carex lanuginosa</i>
<i>Lonicera involucrata</i>		<i>Geranium richardsonii</i>	
<i>Betula occidentalis</i>			

POOL ATTRIBUTES

% area in pools: 0

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 100

% bank length with overhanging vegetation: 65 (more below or downhill)

BANK CONDITION

% bank length vegetated, stable: 35

% bank length unvegetated, stable: 65

% bank length vegetated, unstable: 0

% bank length unvegetated, unstable: 0

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) This was an area that includes 2 springs near each other. Previous data (Oct. 2003) was taken at the head of the springs; water diffused downslope over a broad area in which data collection would have been difficult and possibly ambiguous.

2) The area was dry again this sample period (Oct. 2005) due to a large sandstone cliff failure and rockslide over the entire spring area. A few riparian species remained, but not many. It's

basically an upland-looking community at this time. Yet some riparian or mesic species may be increasing such as horsetail, sedge and geranium.

3) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method. I found both end stakes on the previous transect line. Green Line: Also measured on transects.

4) As mentioned last sample period, some seeps may be beginning to form again below the sample area because riparian species such as *Carex lanuginosa*, *Salix* sp., *Betula occidentalis*, and *Rosa woodsii* were beginning to show up, but the historical spring still remains mostly absent.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

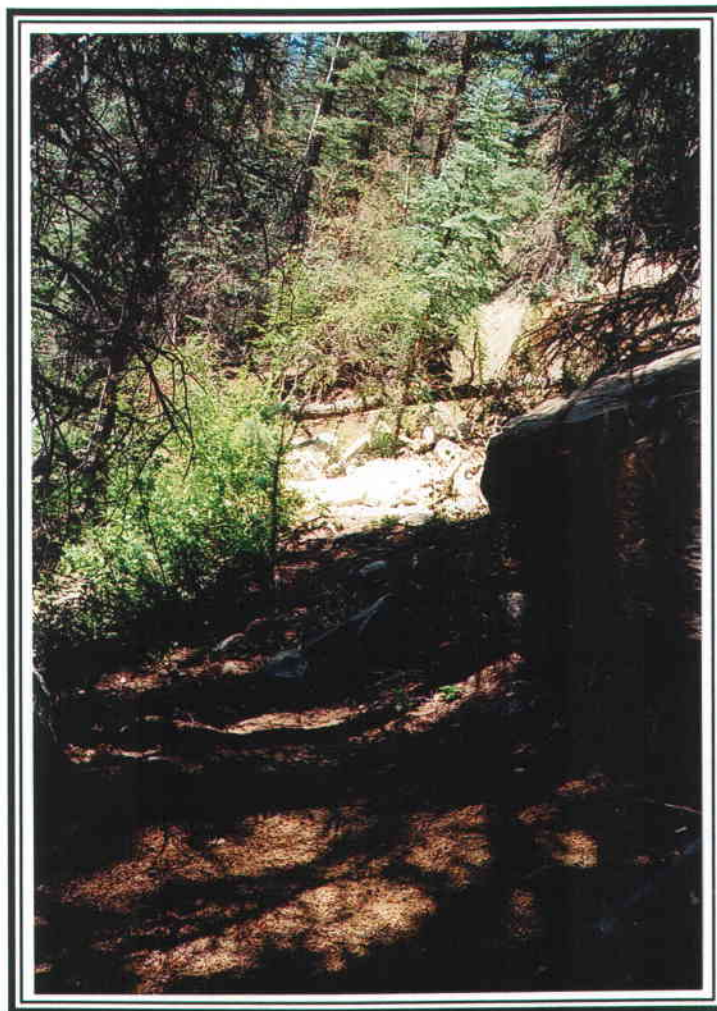
Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-S2	EFB-12	Left	0.0	<i>Equisetum arvense</i>
		Right	10.0	<i>Geranium richardsonii</i> / <i>Equisetum arvense</i>
		Channel	n/a	

EFB-S2 (EFB-12): Cover by community types in Box Canyons (July 2008)

USDA Forest Service Protocol (1992)

	Cover (ft)
UPLAND VEGETATION	
<i>Populus tremuloides</i>	16.00
RIPARIAN VEGETATION	
<i>Geranium richardsonii</i> / <i>Equisetum arvense</i>	10.00
TOTAL COVER (Upland Species)	16.00
TOTAL COVER (Riparian Species)	10.00
BAREGROUND/LITTER	45.00
ROCK	8.00
WATER/MUD/DRY CHANNEL	0.00
MOSS	0.00
TOTAL COVER	79.00

PHOTOGRAPHIC DOCUMENTATION



EFB-S2 (EFB-12)

RIPARIAN COMPLEX DATA SHEET

July 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-S3 - North & South (EFB-13)

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: July 28 - July 31, 2008

OBSERVER(S): P. Collins; K. Collins

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss/Blackhawk Fm

ASPECT: W

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: ~2-30°

ELEVATION: 8,245 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%

MORE SOILS INFORMATION:

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Ponderosa Pine

Right: Ponderosa Pine

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: Unstable, no longer considered "climax".

APPARENT FORAGE TREND: unstable

ESTIMATED FORAGE PRODUCTION: 250 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Symphoricarpos oreophilus</i>	<i>Equisetum arvense</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Juniperus communis</i>	<i>Geranium richardsonii</i>	<i>Elymus trachycaulus</i>
<i>Pinus ponderosa</i>	<i>Rosa woodsii</i>		
<i>Salix amygdaloides</i>			
<i>Cornus stolonifera</i>			

POOL ATTRIBUTES

% area in pools: 0

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 100

% bank length with overhanging vegetation: 60

BANK CONDITION (North/South)

% bank length vegetated, stable: 5/0

% bank length unvegetated, stable: 90/100

% bank length vegetated, unstable: 0

% bank length unvegetated, unstable: 0

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method. Green Line: Also measured on these transects.

- 2) I found the line stakes. I measured north S3 (30 ft) and south S3 (31 ft) separately.
- 3) This spring area has gone dry.
- 4) Riparian species present but decreased since October 2003; seem at equilibrium now.
- 5) There were wetland/riparian species (see Green Line data).
- 6) The understory in the area was mostly bareground.
- 7) Difficult to call data here; almost no riparian species left here.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

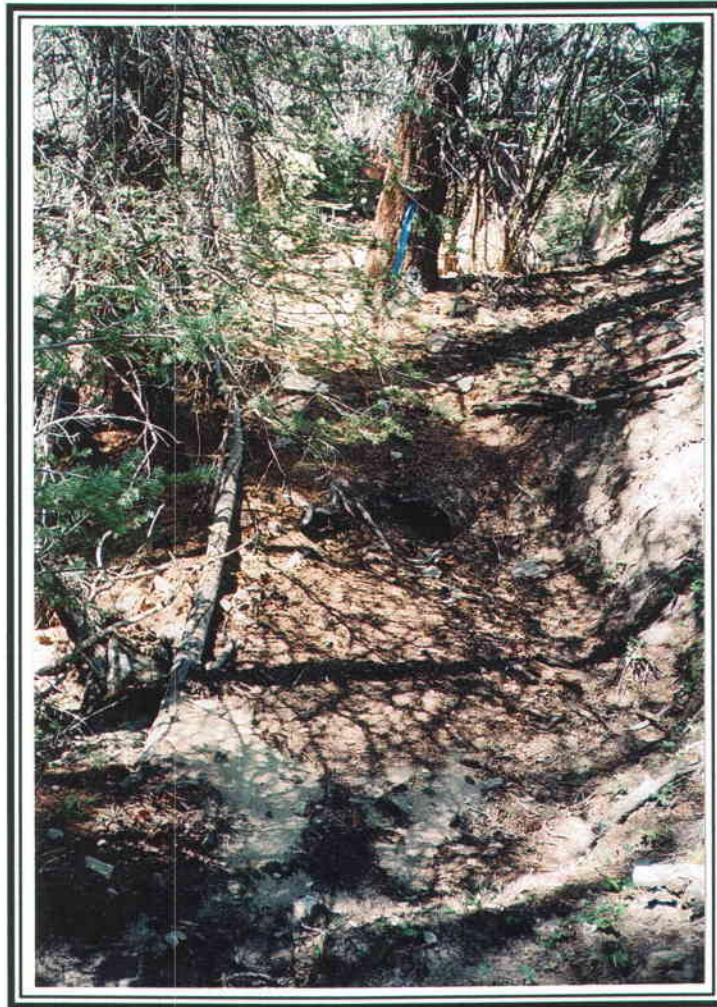
Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-S3	EFB-13	North	1.0	<i>Agrostis stolonifera/Ranunculus cymbalaria</i>
		South	0.0	
		Channel	n/a	

EFB-S3 (EFB-13): Cover by community types in Box Canyons (July 2008)

USDA Forest Service Protocol (1992)

	Cover (ft)
UPLAND VEGETATION	
<i>Populus tremuloides/Picea pungens</i>	60.00
RIPARIAN VEGETATION	
<i>Agrostis stolonifera/Ranunculus cymbalaria</i>	1.00
TOTAL COVER (Upland Species)	60.00
TOTAL COVER (Riparian Species)	1.00
BAREGROUND/LITTER	0.00
ROCK	0.00
WATER/MUD/DRY CHANNEL	0.00
MOSS	0.00
TOTAL COVER	61.00

PHOTOGRAPHIC DOCUMENTATION



EFB-S3 (EFB-13) South

RIPARIAN COMPLEX DATA SHEET

July 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-S4 (EFB-14)

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: July 28 - July 31, 2008

OBSERVER(S): P. Collins; K. Collins

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss/Blackhawk Fm

ASPECT: W

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: ~25°

ELEVATION: 8,240 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%

MORE SOILS INFORMATION:

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Horsetail (uphill)/Spruce

Right: Horsetail (uphill)/Spruce

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: not climax.

APPARENT FORAGE TREND: Unstable

ESTIMATED FORAGE PRODUCTION: 100 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Symphoricarpos oreophilus</i>	<i>Geranium richardsonii</i>	<i>Festuca ovina</i>
<i>Populus tremuloides</i>	<i>Potentilla fruticosa</i>	<i>Equisetum arvense</i>	
<i>Salix amygdaloides</i>	<i>Rosa woodsii</i>		

POOL ATTRIBUTES

% area in pools: 0 (no water present)

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 0

% bank length with overhanging vegetation: 65

BANK CONDITION

% bank length vegetated, stable: 30

% bank length unvegetated, stable: 30

% bank length vegetated, unstable: 10

% bank length unvegetated, unstable: 30

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) Spring area. There was a seep here during the first sample period (Oct 2003). It was dry leaving bareground for last sample periods. Some riparian species remain. The entire transect area was dominated by horsetail with some redtop this period (probably should be zero riparian due to spring water loss).

- 2) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method. Green Line: Also measured on these transects.
3) I'm not sure why the transect measures 19 ft this sample period, while other times it measured 25 ft. *Measured 19 ft this sample period.*

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-S4*	EFB-14	Left	11.0	<i>Equisetum arvense</i>
		Right	4.0	<i>Equisetum arvense</i>
* (see notes above)		Channel	4.0	Bareground

EFB-S4 (EFB-14): Cover by community types in Box Canyons (July 2008)

<u>USDA Forest Service Protocol (1992)</u>		Cover (ft)
UPLAND VEGETATION		
<i>Populus tremuloides/Festuca ovian</i>		4.00
RIPARIAN VEGETATION		
<i>Equisetum arvensis</i>		15.00
TOTAL COVER (Upland Species)		4.00
TOTAL COVER (Riparian Species)		15.00
BAREGROUND/LITTER		0.00
ROCK		0.00
WATER/MUD/DRY CHANNEL		0.00
Moss		0.00
TOTAL COVER		19.00

PHOTOGRAPHIC DOCUMENTATION



EFB-S4 (EFB-14)

RIPARIAN COMPLEX DATA SHEET
July 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number RE-11

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: July 28 - July 31, 2008

OBSERVER(S): P. Collins; K. Collins

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: N

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: ~2°

ELEVATION: 8,265 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Wood's Rose/Aspen

Right: Aspen/Spruce

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: climax (but recent years' upper bank movement could influence status).

APPARENT FORAGE TREND: decreasing

ESTIMATED FORAGE PRODUCTION: 30 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Rosa woodsii</i>	<i>Equisetum arvense</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>			

POOL ATTRIBUTES

% area in pools: 50

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 80

% bank length gently sloping (>135°): 50 (above undercuts)

% bank length with overhanging vegetation: 30

BANK CONDITION

% bank length vegetated, stable: 10

% bank length unvegetated, stable: 20 (40% riparian cover on left; 0 on right; \bar{x} = 20%)

% bank length vegetated, unstable: 10

% bank length unvegetated, unstable: 40

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable):
unstable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) Sideslopes were noted as unstable in Fall 2003. The Spring 2004 sample period revealed that a large spruce tree had fallen directly on the sample area. The upland areas were unstable and movement of sample markers was observed. There were no riparian species in the transect area due to the fallen tree and extensive cattle disturbance in Spring and Fall 2004. Riparian species are returning here. In July 2005, right side had *Equisetum arvense* from hillside water. One sample period (October 2005) had some *Equisetum arvense* and *Agrostis stolonifera*. In July 2008, there was redtop on one side only.

2) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method. Green Line: Also measured on these transects.

- 3) During the flood of July 2006 vegetation was impacted. Also more erosional undercutting was observed. The upper left bank had more green vegetation that had moved downward (sloughing). Riparian spp. had low living cover.
- 4) I found early study stake under Wood's rose plants.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
RE-11		Left	1.0	<i>Agrostis stolonifera</i>
		Right	0.0	<i>Agrostis stolonifera</i>
		Channel	1.0 4.0	Water Rock

RE-11: Cover by community types in Box Canyons (July 2008)

USDA Forest Service Protocol (1992)

	Cover (ft)
UPLAND VEGETATION	
<i>Populus tremuloides/Rosa woodsii</i>	22.50
RIPARIAN VEGETATION	
<i>Agrostis stolonifera</i>	1.00
TOTAL COVER (Upland Species)	22.50
TOTAL COVER (Riparian Species)	1.00
BAREGROUND/LITTER	0.00
ROCK	1.50
WATER/MUD/DRY CHANNEL	4.00
MOSS	0.00
TOTAL COVER	29.00

PHOTOGRAPHIC DOCUMENTATION



RE-11

RIPARIAN COMPLEX DATA SHEET

July 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number RE-12

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: July 28 - July 31, 2008

OBSERVER(S): P. Collins; K. Collins

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: N

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: ~2°

ELEVATION: 8,275 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%
 -

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Sagebrush/Grass

Right: Wood's Rose/Aspen

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: Seral

APPARENT FORAGE TREND: Unstable

ESTIMATED FORAGE PRODUCTION: 100 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Populus tremuloides</i>	<i>Salix</i> sp.	<i>Eriogonum</i> sp.	<i>Agrostis stolonifera</i>
<i>Salix</i> sp.	<i>Artemisia tridentata</i>	<i>Equisetum arvense</i>	<i>Juncus arcticus</i>
	<i>Rosa woodsii</i>		<i>Carex nebrascensis</i>
			<i>Poa secunda</i>

POOL ATTRIBUTES

% area in pools: 0 (no water present)
% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0
% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0
% bank length gently sloping (>135°): 50
% bank length with overhanging vegetation: 5

BANK CONDITION

% bank length vegetated, stable: 25
% bank length unvegetated, stable: 25
% bank length vegetated, unstable: 0
% bank length unvegetated, unstable: 50

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

- 1) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method.
- 2) There was a large sandstone boulder (size of 2 automobiles) that rolled down into the creek bottom from the side-slopes.
- 3) Photo taken from left side.
- 4) No water was present.

6) Heavy flooding was observed July 19-20, 2006. There were lots of sediments within the riparian species, often covering them. Live aspen on the side slopes just above the stream had toppled (photographs are on file).

7) There is usually water present at this site, but not this sample period.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
RE-12		Left	1.5	<i>Agrostis stolonifera</i>
		Right	4.0	<i>Agrostis stolonifera</i> / <i>Carex nebrascensis</i>
		Channel	1.0 2.5	Water Bareground

RE-12: Cover by community types in Box Canyons (July 2008)

USDA Forest Service Protocol (1992)

	Cover (ft)
UPLAND VEGETATION	
<i>Artemisia tridentata</i> / <i>Elymus trachycaulus</i>	13.00
<i>Populus tremuloides</i> / <i>Rosa woodsii</i>	8.00
RIPARIAN VEGETATION	
<i>Agrostis stolonifera</i>	1.50
<i>Agrostis stolonifera</i> / <i>Carex nebrascensis</i>	4.00
TOTAL COVER (Upland Species)	21.00
TOTAL COVER (Riparian Species)	5.50
BAREGROUND/LITTER	2.00
ROCK	0.00
WATER/MUD/DRY CHANNEL	1.00
MOSS	0.00
TOTAL COVER	29.50

PHOTOGRAPHIC DOCUMENTATION



RE-12

RIPARIAN COMPLEX DATA SHEET

July 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number RE-13

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: July 28 - July 31, 2008

OBSERVER(S): P. Collins; K. Collins

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: NW

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 2^\circ$

ELEVATION: 8,315 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Aspen

Right: Aspen/Ponderosa Pine

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: Seral

APPARENT FORAGE TREND: decreasing

ESTIMATED FORAGE PRODUCTION: 50 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Artemisia tridentata</i>	<i>Ranunculus cymbalaria</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Potentilla fruticosa</i>	<i>Equisetum arvense</i>	<i>Carex lanuginosa</i>
<i>Pinus ponderosa</i>	<i>Symphoricarpos oreophilus</i>	<i>Artemisia dracunculus</i>	<i>Elymus trachycaulus</i>
		<i>Erigeron divergens.</i>	<i>Juncus sp.</i>
		<i>Achillea millefolium</i>	<i>Juncus arcticus</i>
		<i>Taraxacum officiale</i>	<i>Festuca ovina</i>
		<i>Potentilla sp.</i>	<i>Poa secunda</i>

POOL ATTRIBUTES

% area in pools: n/a (no water at this site)

% pool area made up of pools > 2' deep: n/a (no water at this site)

AQUATIC VEGETATION

% streambed with filamentous algae: n/a (no water at this site)

% stream margin with rooted aquatic: n/a (no water at this site)

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 0

% bank length with overhanging vegetation: 10

BANK CONDITION

% bank length vegetated, stable: 5

% bank length unvegetated, stable: 10

% bank length vegetated, unstable: 5

% bank length unvegetated, unstable: 80

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

- 1) There was lots of sand on banks and bottoms from the recent flooding.
- 2) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method.
- 3) Site was dry.
- 4) Sandy bottom; unstable side slope and channel banks.

5) The bottomline for this sample period is that there seemed to be more sand on the channel bottom (likely do to flood events) above EFB-07. Additionally, it seemed like there was less riparian vegetation along the reaches, another possible consequence of flooding activities. Also, no water was observed above this sample station.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
RE-13		Left	1.0	<i>Agrostis stolonifera</i>
		Right	2.0	<i>Agrostis stolonifera</i>
		Channel	4.0	Bareground (sand)

RE-13: Cover by community types in Box Canyons (July 2008)

USDA Forest Service Protocol (1992)

	Cover (ft)
UPLAND VEGETATION	
<i>Artemisia tridentata/Elymus trachycaulus</i>	10.50
<i>Populus tremuloides</i>	10.00
RIPARIAN VEGETATION	
<i>Agrostis stolonifera</i>	3.00
TOTAL COVER (Upland Species)	20.50
TOTAL COVER (Riparian Species)	3.00
BAREGROUND/LITTER	4.00
ROCK	0.00
WATER/MUD/DRY CHANNEL	0.00
MOSS	0.00
TOTAL COVER	27.50

PHOTOGRAPHIC DOCUMENTATION



RE-13

RIPARIAN COMPLEX DATA SHEET

July 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number R-07

WATERBODY NAME: Main Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: July 28 - July 31, 2008

OBSERVER(S): P. Collins; K. Collins

QUAD NAME: Emery West, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: NW

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 2^\circ$

ELEVATION: 8,220 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Spruce/Aspen

Right: Aspen/Spruce

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: climax (but recent years' upper bank movement could influence status).

APPARENT FORAGE TREND: stable

ESTIMATED FORAGE PRODUCTION: 75 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Juniperus communis</i>	<i>Achillea millefolium</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Potentilla fruticosa</i>	<i>Equisetum arvense</i>	<i>Carex lanuginosa</i>
<i>Betula occidentalis</i>		<i>Antennaria</i> sp.	
		<i>Artemisia ludoviciana</i>	
		<i>Geranium richardsonii</i>	

POOL ATTRIBUTES

% area in pools: n/a (no water at this site)

% pool area made up of pools > 2' deep: n/a (no water at this site)

AQUATIC VEGETATION

% streambed with filamentous algae: n/a (no water at this site)

% stream margin with rooted aquatic: n/a (no water at this site)

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 30

% bank length gently sloping (>135°): 35

% bank length with overhanging vegetation: 35

BANK CONDITION

% bank length vegetated, stable: 20

% bank length unvegetated, stable: 35

% bank length vegetated, unstable: 10

% bank length unvegetated, unstable: 35

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable (left side); unstable (right side)

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) Photo taken from the left side

2) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method.

- 3) Part of riparian spp. are in the channel (2 ft).
4) No water at site.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
R-07		Left	1.0	<i>Agrostis stolonifera</i> / <i>Carex lanuginosa</i>
		Right	1.0	<i>Agrostis stolonifera</i> / <i>Carex lanuginosa</i>
		Middle	2.0	<i>Carex lanuginosa</i>
		Channel	6.0 8.0	Bareground Rock

R-07: Cover by community types in Box Canyons (July 2008)

USDA Forest Service Protocol (1992)

	Cover (ft)
UPLAND VEGETATION	
<i>Picea pungens</i>	10.00
<i>Populus tremuloides</i>	11.00
RIPARIAN VEGETATION	
<i>Agrostis stolonifera</i>	2.00
<i>Carex lanuginosa</i>	2.00
TOTAL COVER (Upland Species)	21.00
TOTAL COVER (Riparian Species)	4.00
BAREGROUND/LITTER	6.00
ROCK	8.00
WATER/MUD/DRY CHANNEL	0.00
MOSS	0.00
TOTAL COVER	39.00

PHOTOGRAPHIC DOCUMENTATION



R-07

RIPARIAN COMPLEX DATA SHEET

July 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number R-09

WATERBODY NAME: Main Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: July 28 - July 31, 2008

OBSERVER(S): P. Collins; K. Collins

QUAD NAME: Emery West, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: N

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 2^\circ$

ELEVATION: 8,210 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service, 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Spruce/Aspen

Right: Aspen/Horsetail

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: climax (but recent years' upper bank movement could influence status).

APPARENT FORAGE TREND: stable

ESTIMATED FORAGE PRODUCTION: 500 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Salix lutea</i>	<i>Ranunculus cymbalaria</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Artemisia tridentata</i>	<i>Equisetum arvense</i>	<i>Juncus longistylis</i>
<i>Juniperus scopulorum</i>	<i>Rosa woodsii</i>		<i>Juncus arcticus</i>
			<i>Carex lanuginosa</i>

POOL ATTRIBUTES

% area in pools: 0 (dry)

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 40

% bank length gently sloping (>135°): 40

% bank length with overhanging vegetation: 50

BANK CONDITION

% bank length vegetated, stable: 85

% bank length unvegetated, stable: 10

% bank length vegetated, unstable: 0

% bank length unvegetated, unstable: 5

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable (left side); moderately stable (right side)

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) Photo taken from the left side.

2) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method.

3) The left side of the river there were mostly riparian species. It was difficult to tell if it was from hillside water or stream. Seemed more like stream influence.

4) The right side had hillside water influence.

- 5) No water at site.
6) Stream channel between R-07 and R-09 had no running water. There were a couple of rock side pools.

DATA SUMMARIES

GREEN LINE WIDTH (HYDRIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
R-09		Left	5.5	<i>Equisetum arvense</i> / <i>Agrostis stolonifera</i> / <i>Carex lanuginosa</i>
		Right	5.5	<i>Equisetum arvense</i>
		Channel	0.0	Dry

R-09: Cover by community types in Box Canyons (July 2008)

USDA Forest Service Protocol (1992)

	Cover (ft)
UPLAND VEGETATION	
<i>Populus tremuloides</i>	18.00
RIPARIAN VEGETATION	
<i>Carex lanuginosa</i> / <i>Agrostis stolonifera</i>	11.00
TOTAL COVER (Upland Species)	18.00
TOTAL COVER (Riparian Species)	11.00
BAREGROUND/LITTER	0.00
ROCK	0.00
WATER/MUD/DRY CHANNEL	0.00
MOSS	0.00
TOTAL COVER	29.00

PHOTOGRAPHIC DOCUMENTATION



R-09

RIPARIAN COMPLEX DATA SHEET
July 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number R-11

WATERBODY NAME: Main Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: July 28 - July 31, 2008

OBSERVER(S): P. Collins; K. Collins

QUAD NAME: Emery West, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: NNW

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 2^\circ$

ELEVATION: 8,180 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Spruce/Grass

Right: Aspen/Wood's Rose

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: climax (but recent years' upper bank movement could influence status).

APPARENT FORAGE TREND: stable

ESTIMATED FORAGE PRODUCTION: 300 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Rosa woodsii</i>	<i>Epilobium angustifolium</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>		<i>Equisetum arvense</i>	<i>Juncus longistylis</i>
<i>Salix</i> sp.		<i>Ranunculus cymbalaria</i>	<i>Juncus arcticus</i>
			<i>Poa secunda</i>

POOL ATTRIBUTES

% area in pools: dry

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 40

% bank length gently sloping (>135°): 60

% bank length with overhanging vegetation: 10

BANK CONDITION

% bank length vegetated, stable: 40

% bank length unvegetated, stable: 10

% bank length vegetated, unstable: 0

% bank length unvegetated, unstable: 50

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable):
moderately stable (left side); stable (right side)

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

- 1) Photograph taken from the left side.
- 2) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method.
- 3) Right stake was missing. For transect, we measured from aspen tree (see photo) with blue flag.
- 4) Left side ave. 50% veg [ave. of two sides therefore 25% (see Bank Condition above)].
- 5) Left side had more riparian vegetation and less upland.
- 6) Stream channel between R-09 and R-11 had no running water. There were a couple of rock side pools.
- 7) Sample area channel was dry.

8) Channel width was 5 ft (wider than previous sample periods). Channel was sandy and wet. There were very few plants in the stream channel.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

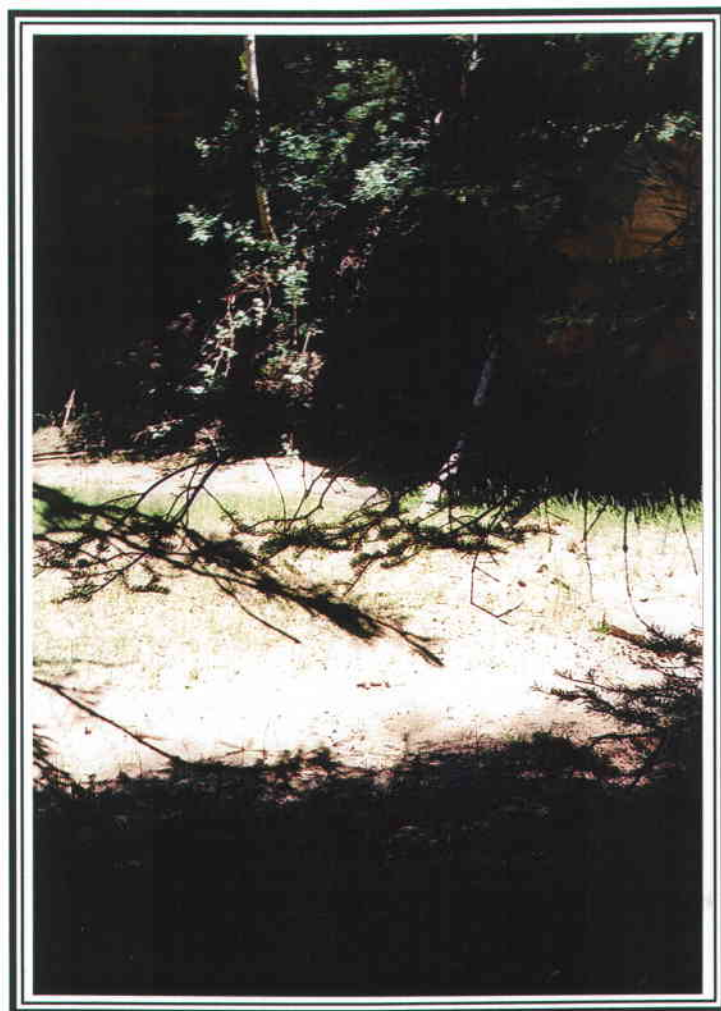
Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
R-11		Left	7.0	<i>Agrostis stolonifera/Juncus longistylis</i>
		Right	0.0	<i>Equisetum arvense/Juncus longistylis</i>
		Channel	5.0	Bareground/mud

R-11: Cover by community types in Box Canyons (July 2008)

USDA Forest Service Protocol (1992)

	Cover (ft)
UPLAND VEGETATION	
<i>Picea pungens/Rosa woodsii</i>	15.00
RIPARIAN VEGETATION	
<i>Equisetum arvense</i>	2.00
<i>Juncus longistylis/Agrostis stolonifera</i>	5.00
TOTAL COVER (Upland Species)	15.00
TOTAL COVER (Riparian Species)	7.00
BAREGROUND/LITTER	5.00
ROCK	0.00
WATER/MUD/DRY CHANNEL	0.00
MOSS	0.00
TOTAL COVER	27.00

PHOTOGRAPHIC DOCUMENTATION



R-11

RIPARIAN COMPLEX DATA SHEET

July 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number R-13

WATERBODY NAME: Main Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: July 28 - July 31, 2008

OBSERVER(S): P. Collins; K. Collins

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: NNW

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 2^{\circ}$

ELEVATION: 8,175 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Spruce

Right: Spruce/Aspen

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: climax (but recent years' upper bank movement could influence status).

APPARENT FORAGE TREND: stable

ESTIMATED FORAGE PRODUCTION: 350 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Potentilla fruticosa</i>	<i>Equisetum arvense</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Juniperus communis</i>	<i>Cirsium</i> sp.	<i>Carex nebrascensis</i>
<i>Salix lucida</i>		<i>Ranunculus cymbalaria</i>	<i>Carex lanuginosa</i>
<i>Salix</i> sp.			<i>Juncus longistylis</i>
			<i>Bromus carinatus</i>
			<i>Elymus trachycaulus</i>
			<i>Juncus arcticus</i>
			<i>Poa fendleriana</i>

POOL ATTRIBUTES

% area in pools: (dry)

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 50

% bank length with overhanging vegetation: 50

BANK CONDITION

% bank length vegetated, stable: 20

% bank length unvegetated, stable: 35

% bank length vegetated, unstable: 15

% bank length unvegetated, unstable: 30

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) There was a discrepancy with total transect length between 1999 (42 ft.) and Oct 2003 (45 ft.); July 2004, October 2004, July 2005, October 2005, July 2006 were consistent at 45 ft, October 2007 (46 ft), July 2008 (46 ft).

2) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method. Green Line: Also measured on these transects.

- 3) Photograph taken from the left side.
- 4) The site was very different this sample period. I called most of the vegetation as 'riparian', but that was questionable because much of the cover of riparian species was quite sparse.
- 5) There was some water in the channel between R-11 and R-13.
- 6) A lot of sandy substrate was deposited at this site from the side channel.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

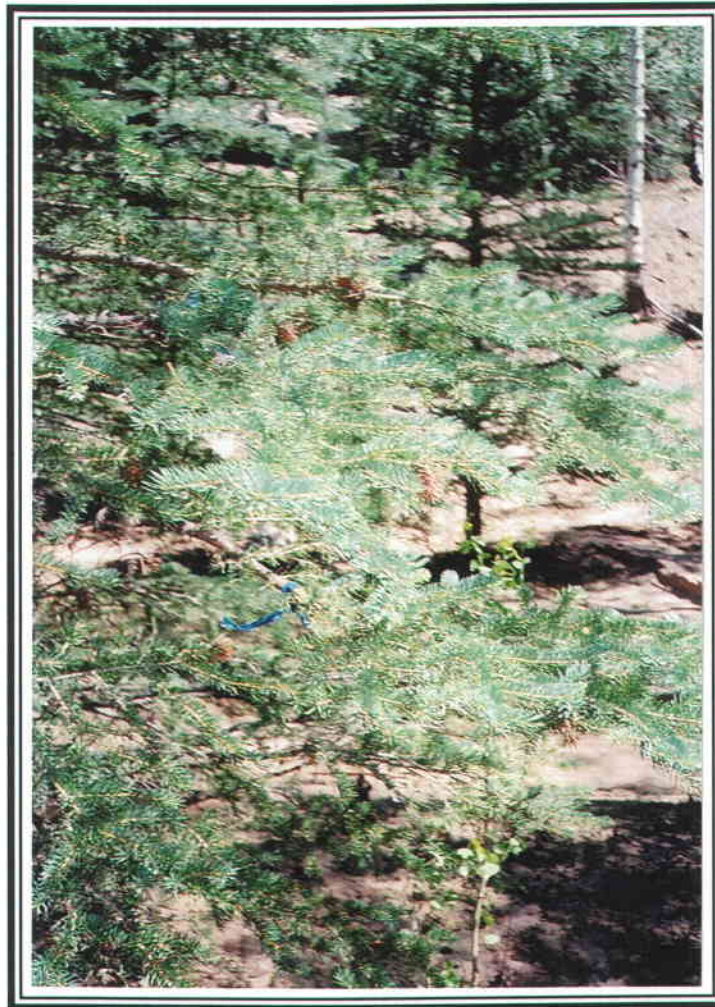
Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
R-13		Left	11.0	<i>Agrostis stolonifera</i> / <i>Carex nebrascensis</i> / <i>Equisetum arvense</i>
		Right	8.0	<i>Salix lutea</i> / <i>Carex nebrascensis</i> / <i>Equisetum arvense</i>
		Channel	7	Bareground

R-13: Cover by community types in Box Canyons (July 2008)

USDA Forest Service Protocol (1992)

	Cover (ft)
UPLAND VEGETATION	
<i>Picea pungens</i>	20.00
RIPARIAN VEGETATION	
<i>Agrostis stolonifera</i> / <i>Equisetum arvensis</i>	19.00
TOTAL COVER (Upland Species)	20.00
TOTAL COVER (Riparian Species)	19.00
BAREGROUND/LITTER	7.00
ROCK	0.00
WATER/MUD/DRY CHANNEL	0.00
MOSS	0.00
TOTAL COVER	46.00

PHOTOGRAPHIC DOCUMENTATION



R-13

RIPARIAN COMPLEX DATA SHEET
July 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number R-15

WATERBODY NAME: Main Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: July 28 - July 31, 2008

OBSERVER(S): P. Collins; K. Collins

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss (Blackhawk Fm just upstream)

ASPECT: N

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 2^{\circ}$

ELEVATION: 8,170 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Spruce/Aspen

Right: Spruce

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: active movement (not climax)

APPARENT FORAGE TREND: moderately stable

ESTIMATED FORAGE PRODUCTION: 0 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Juniperus communis</i>	<i>Aster sp.</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Symphoricarpos oreophilus</i>	<i>Equisetum arvense</i>	
<i>Cornus stolonifera</i>	<i>Salix lutea</i>	<i>Epilobium angustifolium</i>	
	<i>Rosa woodsii</i>		

POOL ATTRIBUTES

% area in pools: 20

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 30

% bank length gently sloping (>135°): 5

% bank length with overhanging vegetation: 20

BANK CONDITION

% bank length vegetated, stable: 0

% bank length unvegetated, stable: 65

% bank length vegetated, unstable: 0

% bank length unvegetated, unstable: 35

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable (left side); unstable (right side)

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) Left side had horsetail in the "upland" area, but it was high enough in elevation that we felt it was influenced by side-slope water.

2) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method. Green Line: Also measured on these transects.

3) Length of transect line in Oct. 2003 was less than 1999 due to movement; since that time it has been fairly consistent (25.5 ft July 2008).

- 5) There was no riparian vegetation on the transect line this year.
- 6) Some reaches between R-13 and R-15 had water in the channel.
- 7) The bottomline in the Main Fork between R-07 and R-15 is that there was much more sand deposited in channel bottom. Also the channel appeared wider with less water and less living cover in the riparian zone.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

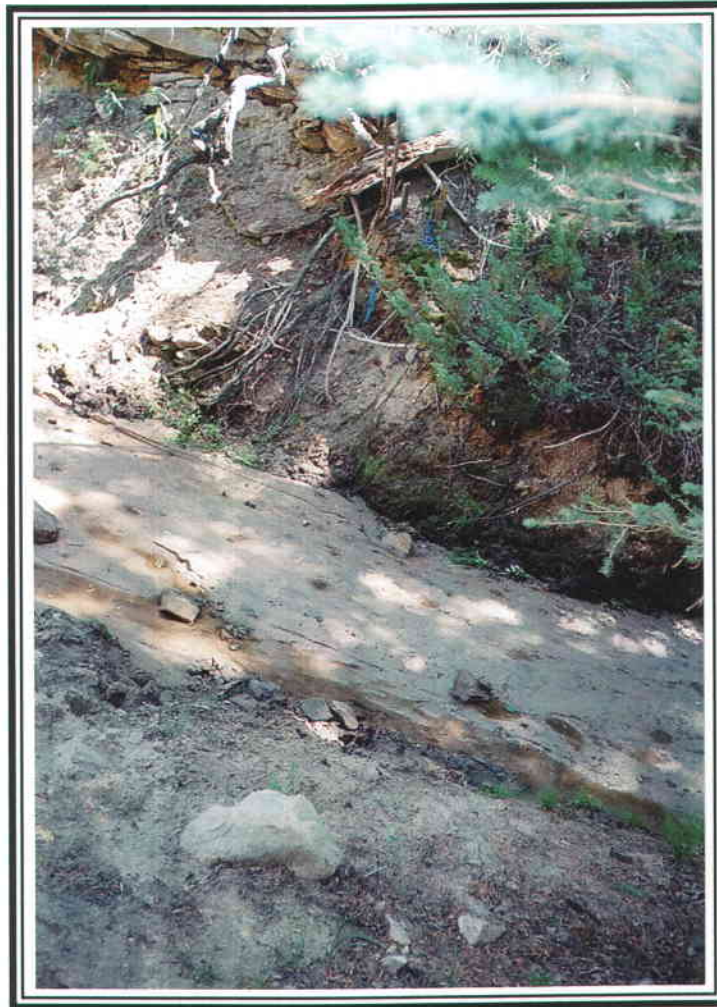
Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
R-15		Left	0.0	<i>Agrostis stolonifera</i>
		Right	0.0	
		Channel	1.0 8.5	Water Bareground/Rock

R-15: Cover by community types in Box Canyons (July 2008)

USDA Forest Service Protocol (1992)

	Cover (ft)
UPLAND VEGETATION	
<i>Populus tremuloides/Picea pungens</i>	18.00
RIPARIAN VEGETATION	
<i>Equisetum arvensis</i>	3.00
TOTAL COVER (Upland Species)	18.00
TOTAL COVER (Riparian Species)	3.00
BAREGROUND/LITTER	0.00
ROCK	0.00
WATER/MUD/DRY CHANNEL	0.00
MOSS	0.00
TOTAL COVER	21.00

PHOTOGRAPHIC DOCUMENTATION



R-15

**Riparian Plant Communities
in the
East Fork of Box Canyon
October 2008**



A Vegetation Monitoring Study
for the
SUFCO Mine:
October 2008

Prepared by

MT. NEBO SCIENTIFIC, INC.
330 East 400 South, Suite 6
Springville, Utah 84663
ph. 801.489.6937

by

Patrick D. Collins, Ph.D.

for

CANYON FUEL COMPANY, LLC.
397 S SR 24
Salina, Utah 84654

April 2009



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INTRODUCTION

Previous Studies

Underground coal mining was scheduled and conducted below the East Fork of Box Canyon by the SUFCO Mine during the winter of 2003-04. Possible impacts to the riparian plant communities supported in the East Fork of Box Canyon caused by subsidence as a result of the mining activities have been studied prior to, and subsequent of, mining in this area. This study includes results from quantitative and qualitative vegetation monitoring in several locations in the East Fork and Main Fork of Box Canyon for the **October 2008** sample period.

This document provides the *ninth* and *final* sample period of monitoring data for the existing riparian plant communities in the two forks of Box Canyon. It also compares the results of the most telling parameters of previous sample periods.

Results from previous studies conducted in the East Fork and Main Fork of Box Canyons were reported and submitted to Canyon Fuel Company in the following documents:

- *Riparian Plant Communities in the East Fork of Box Canyon: 2003*
- *Riparian Plant Communities in the East Fork of Box Canyon: July 2004*
- *Riparian Plant Communities in the East Fork of Box Canyon: October 2004*
- *Riparian Plant Communities in the East Fork of Box Canyon: July 2005*
- *Riparian Plant Communities in the East Fork of Box Canyon: October 2005*
- *Riparian Plant Communities in the East Fork of Box Canyon: July 2006*
- *Riparian Plant Communities in the East Fork of Box Canyon: October 2006*
- *Riparian Plant Communities in the East Fork of Box Canyon: July 2008*

The Study Areas

The Box Canyons and their drainages are located at the southern end of the Wasatch Plateau, a subprovince of the Colorado Plateau Physiographic Province. This area is in Sevier County, Utah west of the town of Emery, and is located within the Manti-LaSal National Forest. The Box Canyon drainages are tributaries to Muddy Creek which runs into the Dirty Devil River and ultimately drains into the Colorado River. Geology of the study areas was within the Cretaceous strata of the Mesa Verde Group. The upper portions of the study area were comprised of rocks and soils derived from the cliff-forming Castlegate Sandstone. The lower reaches of the study area encounters shales of the Blackhawk Formation. Elevation of the study area was between 8,000 ft to 8,500 ft above sea level.

This study concentrated on the riparian plant communities within the East Fork of Box Canyon because underground mining had been proposed in this area. However, because no mining was planned underneath the Main Fork of Box Canyon, some "control" sample stations were also placed in this drainage.

A variety of biological and other resource information can be studied to evaluate and characterize riparian complexes including vegetation, geology, channel morphology, aquatic biology, soils, and stream flow. The primary focus of this study was on the vegetation as to provide baseline and followup information by monitoring the riparian communities in the East Fork of Box Canyon. Regular monitoring was conducted to provide data to determine long term trends, natural variability and benchmark information including the possible impacts on the riparian plant communities from mining beneath the creek.

Like the previous studies, this study primarily employed vegetation monitoring methods described by the USDA Forest Service for a "Level III Riparian Area Evaluation". The design of this study was not to provide data that could show subtle changes to community structure and species composition as a result of *minor* changes to the riparian habitat. Rather, the study was designed to be compared with earlier studies in an attempt to document *major* impacts to the plant communities along the stream due to catastrophic events, such as loss of water and habitat from the effects of subsidence caused from underground mining.

METHODS

Sample station locations were pre-determined from an early field visit in 2003 by a team of specialists and representatives from the State of Utah, Division of Oil, Gas & Mining (DOGM), Canyon Fuel Company (CFC), USDA Forest Service (USFS), Mt. Nebo Scientific, Inc., Petersen Hydrologic, LLC and other consultants. These stations were placed in areas with the intent to provide similar study areas where data could be recorded in several disciplines including biology, hydrology and geology. These sample stations are called "team stations" in this report.

The vegetation monitoring methods of the study were principally based on those described by the USDA Forest Service for a "Level III Riparian Area Evaluation" (Integrated Riparian Evaluation Guide, March 1992), but do expand on those methodologies.

RIPARIAN COMPLEX DATA SHEET

CLIENT:
 COMPLEX: Riverine - Number
 WATERBODY NAME:
 LOCATION:
 DATE:
 OBSERVER(S):
 QUAD NAME:
 GEOLOGIC PARENT MATERIAL:
 ASPECT:
 VALLEY BOTTOM TYPE:
 STREAM GRADIENT:
 ELEVATION: .
 SIZE OF COMPLEX:
 SOILS INFORMATION:
 ADJACENT UPLAND VEGETATION (looking downstream)
 Left: Right:
 VEGETATIVE DESCRIPTION (Dominance by Community Types)
 SUCCESSIONAL STATUS:
 APPARENT FORAGE TREND:
 ESTIMATED FORAGE PRODUCTION:
 BEAVER ACTIVITY:
 PHOTOGRAPH TAKEN: (from right side unless otherwise stated)
 LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA:
 SPECIES OBSERVED:
 POOL ATTRIBUTES
 % area in pools:
 % pool area made up of pools > 2' deep:
 AQUATIC VEGETATION
 % streambed with filamentous algae:
 % stream margin with rooted aquatic:
 BANK TYPE & VEGETATION OVERHANG
 % bank length undercut (<90°):
 % bank length gently sloping (>135°):
 % bank length with overhanging vegetation:
 BANK CONDITION (bankfull area only)
 % bank length vegetated, stable:
 % bank length unvegetated, stable:
 % bank length vegetated, unstable:
 % bank length unvegetated, unstable:
 BANK STABILITY (near water line):
 CHANNEL MORPHOLOGY
 NOTES:

Qualitative and quantitative data were recorded at each sample location. Although some maintenance was required, locations and extent of the line transects were semi-permanently marked using numbered and flagged wooden stakes and 12-inch metal nails. Photographic stations for documentation and future comparisons were established at each sample location.

In this report, when reference is made to the left or right side of the drainage, this means "river left" or "river right", as characterized by looking downstream.

Qualitative Data

The "Riparian Complex Data Sheet" on the previous page lists all of the qualitative data (and some of the quantitative data) that were collected at all sample stations.

Quantitative Data

As mentioned previously, USFS protocol was utilized for the study. However, to increase the level of detail, some modifications to this protocol were employed to those sample areas chosen by the team specialists (team stations). The primary reason for the modifications were twofold. First, it will provide more diverse datasets, or other ways to measure potential changes to the vegetation in the canyons. Second, there is an existing baseline data set that was recorded in 1999 for the riparian communities in the two Box Canyons. With only a couple of exceptions, the sample areas in the 1999 dataset were different than the team stations of the subsequent studies. Although data began to be recorded again in 2003 and 2004 at some of the same sample locations as were used in 1999, in an attempt to maintain standardized datasets, the modifications to the protocol were not made at these stations. Some of the 1999 stations were located for the 2003 and 2004 studies so that, if necessary, they may provide worthwhile information through time that otherwise would not have been available with one baseline dataset.

With the one exception to the protocol modification mentioned above, the parameters for all sample stations in the 2003, 2004, 2005, 2006 and 2008 studies were identical. The modification to the USFS protocol was in the methods that cover data were recorded. Depending on the site, three different methods were employed to measure cover. They are explained below.

Total Cover

For all the team stations, "total cover" was recorded using point-intercept (or point-quadrat) method. First, transect lines were established perpendicular to the stream channel. With a few exceptions such as constraints imposed by rock ledges or other topographical features, the transect line lengths were consistent, or 24 ft. on each side of the stream. The length of the transect lines extended far enough upslope to insure that they also included upland vegetation types (usually 3 quadrats on each side) as well as the riparian vegetation being sampled. The transect lines on each side of the stream began at the bottomland near the edge of the water, or where the riparian vegetation began. In some cases, no water was present at a given sample site.

In those instances, the transect lines began where the water would normally be present (i.e. sandy or rock bottom). Water or dry channel widths were measured and added to the total length of the transects.

Regular points were placed at 3 ft. intervals on the transect lines. At these points, point quadrats were used to record the total cover. Cover by these "hits" could include the plant species, moss, litter, bareground or rock. Therefore, total cover when the data were summarized, included 1) percent of the living cover of each plant species, 2) total living cover (vascular), 3) total living cover (nonvascular), 4) litter cover, 5) bareground cover, and 6) rock cover.

Community Type Cover

The Community Type Cover was one method to record cover in the USFS Level III protocol and was used in those additional areas that were added to the riparian study. In other words, these areas were part of the 1999 study and were added to the study *in addition to* those chosen by the team. (In a few areas, the sample locations chosen by the team and those from the 1999 study were the same – in those cases, both methods for estimating cover were employed).

At the sample locations, transects lines were placed across (or perpendicular to) the stream channel. The line transects had varied lengths by design which were based on several factors. Although sometimes limited by topographical features such as sandstone cliffs, the intent was to make the transects long enough to cover the entire stream, its riparian communities, plus an additional 10 ft on each side of the stream to record the adjacent upland communities. Monitoring the total extent of the riparian plant communities including some upland community information should provide information about possible increases or decreases in the riparian communities relative to the adjacent upland communities.

Once the transect was placed, the line-intercept method was employed measuring the extent of each major riparian plant community. The plant communities were named by the dominant two plant species. If only one species dominated the community by a wide margin, the plant community was named by this single species. In this method, cover by each plant species is not calculated.

Green Line Cover

In addition to the methods for estimating cover described above, "Green Line" cover was also recorded at *all sample locations*. This method consisted of using a tape to measure the riparian community (Green Line) on each side of the stream and perpendicular to it. Similar to the Community Type cover described above, the dominant one or two species were listed with each measurement. Results from the Green Line method are similar to the Community Type method in that it quantifies the extent of the riparian community of each sample site. Differences are that the Green Line method separates the riparian data for each side of the stream, whereas the Community Type method provides total cover including: riparian community types, upland community types, bareground, litter, rock and stream.

Site Numbers

The sample sites that were pre-determined by the team of specialists (team stations) that will be used for studies other than those for this report were numbered accordingly and will be consistent with those other studies (geology and hydrology). However, those additional sites that were chosen to supplement the datasets, or the subset of riparian sites that were sampled in 1999, were numbered to be consistent with those sample sites. In some cases, they are the same location. A summary to clarify the numbered sites and the cover sampling method used at each site is shown in the RESULTS section below.

RESULTS

Listed below is a summary of the sample locations, site numbers and protocol used.

Sample Site Number	Other Name or Number	USFS Level III Protocol	Cover Protocol: Green Line	Cover Protocol: Point Quadrat	Cover Protocol: Community Type
EFB-1		X	X	X	
EFB-2		X	X	X	
EFB-3		X	X	X	
EFB-4		X	X	X	
EFB-5		X	X	X	
EFB-6		X	X	X	
EFB-7		X	X	X	
EFB-8		X	X	X	
EFB-9	RE-10	X	X	X	X
EFB-10	RE-09	X	X	X	X
EFB-11		X	X	X	
EFB-S1*		X	X		X
EFB-S2*	EFB-12	X	X		X
EFB-S3*	EFB-13	X	X		X
EFB-S4*	EFB-14	X	X		X
RE-11		X	X		X
RE-12		X	X		X
RE-13		X	X		X
R-07		X	X		X
R-09		X	X		X
R-11		X	X		X
R-13		X	X		X
R-15		X	X		X
*S= Spring					

Sample results are shown for each site on the data sheets in this report. Each sheet shows all qualitative and quantitative data recorded as well as photographic documentation. Sample locations were plotted on USGS 7.5 Minute Series Quadrangle topographic maps: Flagstaff Peak, Utah and Emery West (see Maps 1 thru 4).

DISCUSSION & SUMMARY

This is the *final* sample period for riparian plant community studies planned to monitor potential subsidence impacts from coal mining activities underneath the East Fork and Main Fork of Box Canyons. Results from monitoring the riparian communities in October 2008 in these areas have been presented in this report. USDA Forest Service protocol and other methods were employed to monitor the riparian areas. These methods utilized the results from qualitative data of the riparian complex such as geology, geomorphology, biology, physiognomy, soils, and channel characteristics as part of the data collection process. Quantitative data were also recorded in the riparian plant communities. A total of 23 sample stations were placed in the forks of Box Canyon. The methods used to record cover data at the team stations employed the use of point quadrats to record *Total Cover*. Additional sample stations from a previous study (1999) were also added to the sampling regime in October 2003, July 2004, October 2004, July 2005, October 2005, July 2006, October 2006, July 2008 and October 2008. Five of these previous sample stations were located in the East Fork of Box Canyon and five were in the Main Fork of Box Canyon. Methodologies to estimate cover (*Community Cover*) for the additional sites remained consistent with the earlier studies so that comparisons could be made later. A method referred to as the *Green Line Method* for measuring the riparian communities was also employed at all sample locations. Summaries of all qualitative and quantitative data taken at each sample location are shown in the RESULTS section of this report.

As suggested in an earlier monitoring report (July 2005 sample period), after reviewing the datasets for each sample period, the Community Cover and Green Line methods appear to be more conducive to noting changes in the riparian plant communities. Consequently, these methods have been emphasized in this discussion.

Monitoring reports from previous sample periods suggested that many of the riparian communities in the upper reaches of the East Fork of Box Canyon (sample stations EFB-1, EFB-2, EFB-3, EFB-4, EFB-05, EFB-6) have fluctuated somewhat, but have basically returned to the values close to those reported in first baseline studies. In other words, the riparian zones in these reaches have remained relatively constant (Fig. 1). The total cover values (including living cover, rock, bareground and litter) as sampled using the point-intercept methods changed the most between in these sample areas (see Cover Using Point Quadrats tables on the data sheets at each station), but these changes seemed to be more a result of grazing practices, or possibly seasonal changes rather than from mining influences.

The riparian zones seemed to decrease below (downstream from) EFB-6. Since no two sample areas appeared to have the exact same results over time, changes are best considered on a sample

station-by-station basis. Accordingly, data has been plotted on charts to illustrate changes over time from the October 2003 through the October 2008 sample periods (Figs. 1 *thru* 4).

To facilitate this review, the data in the figures were summarized in groups. In Fig. 1, the data show the results over time for sample stations EFB-1 through EFB-8 using the *Green Line* method. In Fig. 2, the data were also grouped by site numbers, or RE-09 through RE-13, using the *Community Type Cover* method, a method similar to the Green Line method. Data summaries shown in Fig. 1 and Fig. 2 are comparable to each because both show the cover width of the riparian communities (or Green Lines) in feet over time. (NOTE: Some of the sample stations have two identification names; refer to the RESULTS section above for cross-referencing).

As can be observed in Fig. 1 where most of the upper stations are illustrated, many of the riparian plant communities have remained relatively stable over time. In the sample stations of the lower reaches of the East Fork of Box Canyon, as shown on Fig. 2, results were more dynamic. In these sample locations, results suggest a decline in many of the riparian plant communities from October 2003 to July 2004. From July 2004 to October 2005 the communities seem to stabilize, then begin to increase where some reached or exceeded their original (2003) values. Then from October 2005 to October 2006 there was an obvious decrease in the riparian zone width in several of these sample stations (RE-09, RE-10, RE-11, RE-12, RE-13).

Abrupt decreases in the riparian community widths in July 2006 and October 2006 were, in all probability, due the flooding that occurred in the area – especially on July 19th when it rained 1.22 inches within an hour time period. This event was witnessed by the author; severe flooding occurred in the East Fork of Box Canyon and severe bank erosion was witnessed that day. Also worth noting was the storm event that occurred October 6, 2006 when it rained 1.79 inches that day. The decrease in the riparian corridors, especially where the channels were more narrow (i.e. lower East Fork) was more than likely a result of these flash floods.

Fig. 3 shows the results of the sample stations that were placed in spring areas. In all but one of the sites, there was a rather drastic decrease in the riparian communities especially between October 2003 and July 2004. The trend for the spring areas was to increase after that, but not to the values recorded in October 2003. One spring area (EFB-S1) maintained its riparian community for the first three sample periods, then decreased and remained consistent, finally rebounding to its original values by October 2008. This spring appeared to retain more water than the upper elevation springs that nearly dried up completely beginning sometime during the spring of 2004.

Although many of the environmental conditions in the Main Fork of Box Canyon were not exactly the same as those in the East Fork, they were the best “control” conditions found at the time the studies began in 2003 (plus, there was the benefit of earlier recorded 1999 data). Consequently, five of these sites were also monitored during the same periods as the East Fork monitoring regime. Fig. 4 shows that three of the five sample sites (R-07, R-11, R-15) have

fluctuated, but have remained relatively constant from October 2003 through October 2008. The remaining 2 stations (R-09, R-13) have had significant decrease in riparian zones. The above-mentioned affects of the storm events noted in the East Fork of Box were not noted in the Main Fork of Box Canyon during the same time period, but evidence from similar events were noted in R-09 and R-13 – most notably large quantities of sand that were obviously deposited by similar unwitnessed and localized storm events, some of which may have also impacted the East Fork of Box Canyon.

In conclusion, the riparian zones in the main channel of the lower reaches of the East Fork of Box Canyon seemed to be greatly impacted by localized and intense storm events. Sampling conducted on the upper reaches of the East Fork of Box Canyon did not reflect the same results, but water noted in the qualitative data sheets was not as prevalent and the reaches appeared to have had drier and more sandy bottoms when compared to early sample periods. Impacts of subsidence from coal mining, although cannot be ruled out, seem to have had much less impact to the riparian communities than these storm events. That said, there were some relatively short reaches where flows temporally stopped along the stream channel in lower East Fork of Box Canyon. This likely could have been the result of subsidence by coal mining activities, unless it can be documented that the annual precipitation in the area was greatly reduced (a subject not addressed in this report). Also, there was an area where a mudflow from the east side of the stream covered the riparian zone between sample stations EFB-10 and EFB-11. The mudflow followed the mining activities, so it may have been the result of subsidence. Although the riparian zones in these areas were impacted, they did not occur where the semi-permanent sample stations had been placed, so no direct quantitative data are available. The greatest impact by subsidence to the riparian communities appeared in the spring areas (EFB-S2, EFB-S3, EFB-S4). These springs were virtually eliminated or displaced – a probable consequence of the subsidence caused by mining activities.

FIG. 1: EAST FORK BOX CANYON

RIPARIAN ZONE: GREEN LINE METHODS

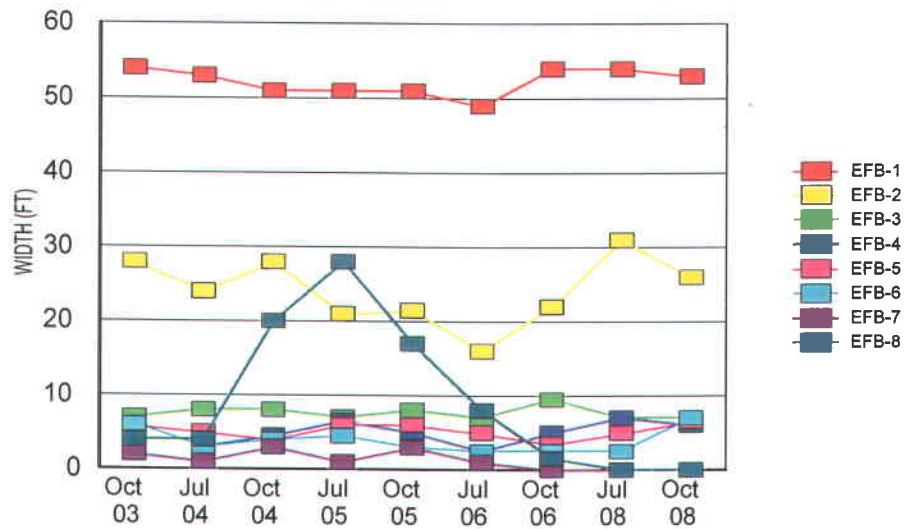


FIG 2: EAST FORK BOX CANYON

RIPARIAN ZONE: COMMUNITY METHODS

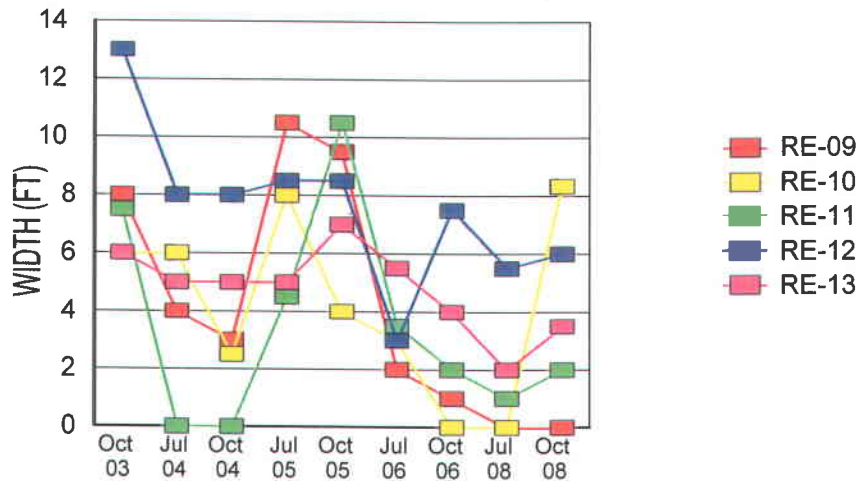


FIG 3: EAST FORK BOX CANYON

RIPARIAN ZONE: GREEN LINE METHODS (SPRINGS)

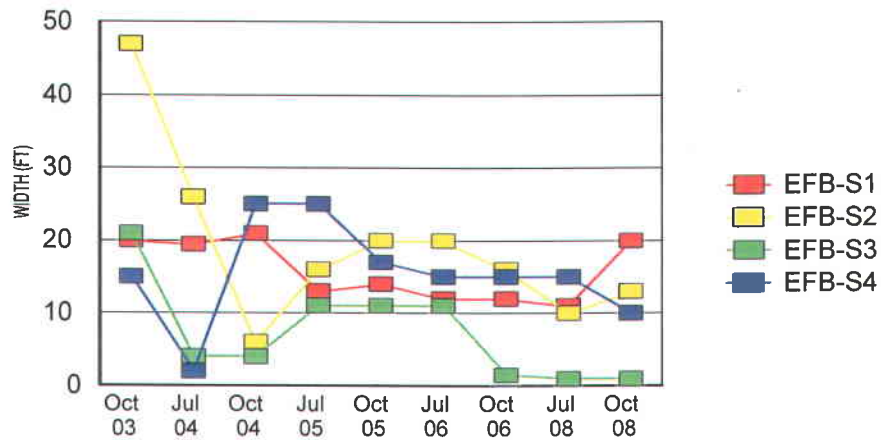
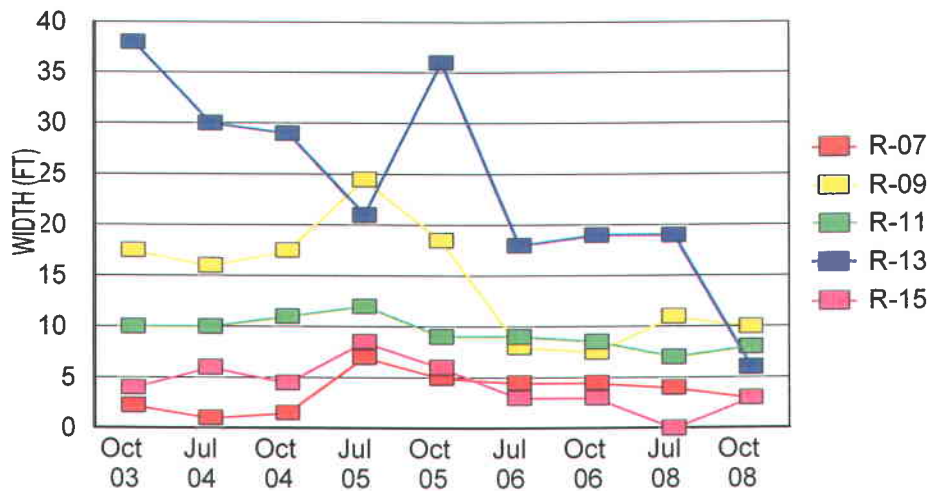


FIG 4: MAIN FORK BOX CANYON

RIPARIAN ZONE: COMMUNITY METHODS



RIPARIAN COMPLEX DATA SHEET

October 2008

CLIENT: Canyon Fuel Company

COMPLEX: Number EFB-1

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: October 6-9, 2008

OBSERVER(S): P. Collins; S. Vlietstra

QUAD NAME: Emery West, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: West

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 1^\circ$

ELEVATION: 8,410ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Spruce/Aspen

Right: Aspen

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data results for this information)	

SUCCESSIONAL STATUS: climax

APPARENT FORAGE TREND: stable

ESTIMATED FORAGE PRODUCTION: 800 lbs./acre (lots of grazing in area)

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Potentilla fruticosa</i>	<i>Ranunculus cymbalaria</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Rosa woodsii</i>	<i>Taraxacum officinale</i>	<i>Carex lanuginosa</i>
			<i>Juncus longistylis</i>
			<i>Juncus arcticus</i>
			<i>Poa pratensis</i>

POOL ATTRIBUTES (meadow, no well defined stream channel)

% area in pools: 0

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 0

% bank length with overhanging vegetation: 0

BANK CONDITION

% bank length vegetated, stable: 65

% bank length unvegetated, stable: 25

% bank length vegetated, unstable: 5

% bank length unvegetated, unstable: 5

BANK STABILITY: relatively stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

- 1) This was a meadow area, not a stream. No water present.
- 2) Quantitative Methods: Point quadrats; sampled at 3 ft. intervals; 28+ft. transect on left side; 30 ft. transect on right side (58 ft. 8 in; includes uplands).
- 3) Vegetation was very short due to grazing in area; plant identification was difficult.

DATA SUMMARIES

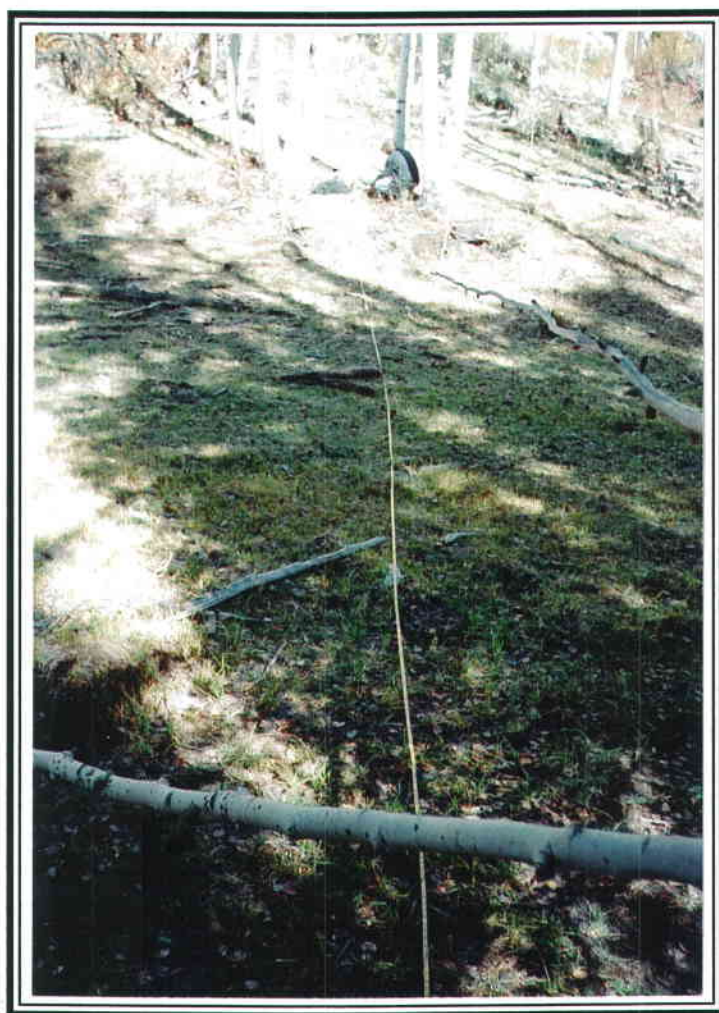
GREEN LINE WIDTH (HYDRIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-1		Left	27.0	<i>Carex lanuginosa</i> / <i>Agrostis stolonifera</i>
		Right	26.0	<i>Carex lanuginosa</i> / <i>Agrostis stolonifera</i>
		Channel	n/a	Dry (no standing water)
		Upland	5'8"	

EFB-1: Cover using point quadrats (October 2008).

COVER BY SPECIES	PERCENT
TREES & SHRUBS	
FORBS	
GRASSES/GRASS-LIKES	
<i>Agrostis stolonifera</i>	15.79
<i>Carex lanuginosa</i>	31.58
TOTAL COVER	
LIVING COVER (vascular)	47.37
WATER	0.00
MOSS	10.53
LITTER	36.84
B/G	5.26
ROCK	0.00
TOTAL	100.00

PHOTOGRAPHIC DOCUMENTATION



EFB-1

RIPARIAN COMPLEX DATA SHEET

October 2008

CLIENT: Canyon Fuel Company

COMPLEX: Number EFB-2

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: October 6-9, 2008

OBSERVER(S): P. Collins; S. Vlietstra

QUAD NAME: Emery West, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: WNW

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: ~1-2°

ELEVATION: 8,380 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Aspen/Sagebrush

Right: Aspen/Sagebrush

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: seral

APPARENT FORAGE TREND: Appear less stable

ESTIMATED FORAGE PRODUCTION: 200 lbs./ac

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, ATV, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Pinus ponderosa</i>	<i>Artemisia tridentata</i>	<i>Achillea millefolium</i>	<i>Juncus arcticus</i>
<i>Populus tremuloides</i>	<i>Potentilla fruticosa</i>	<i>Aster sp.</i>	<i>Agrostis stolonifera</i>
		<i>Potentilla sp.</i>	<i>Poa pratensis</i>
		<i>Taraxacum officinale</i>	<i>Poa secunda</i>
		<i>Campanula parryi</i>	<i>Carex lanuginosa</i>
		<i>Erigeron divergens</i>	

POOL ATTRIBUTES (meadow, no well defined stream channel)

% area in pools: 0 (dry)

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 80

% bank length with overhanging vegetation: 0

BANK CONDITION

% bank length vegetated, stable: 40

% bank length unvegetated, stable: 40

% bank length vegetated, unstable: 0

% bank length unvegetated, unstable: 20

BANK STABILITY: stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

- 1) This was a meadow area, not a stream, but channel was dry.
- 2) Quantitative Methods: Point quadrats; sampled at 3 ft. intervals; 24 ft. transect on left side; 25 ft. transect on right side (48 ft; includes uplands).
- 3) Site was dry. Sandy bottom.
- 4) Meadow was dominated by Kentucky bluegrass; wetter areas of site were dominated by redtop and wiregrass, with some sedge.
- 5) Site seemed drier this period with bare ground present due to grazing and flooding.

DATA SUMMARIES

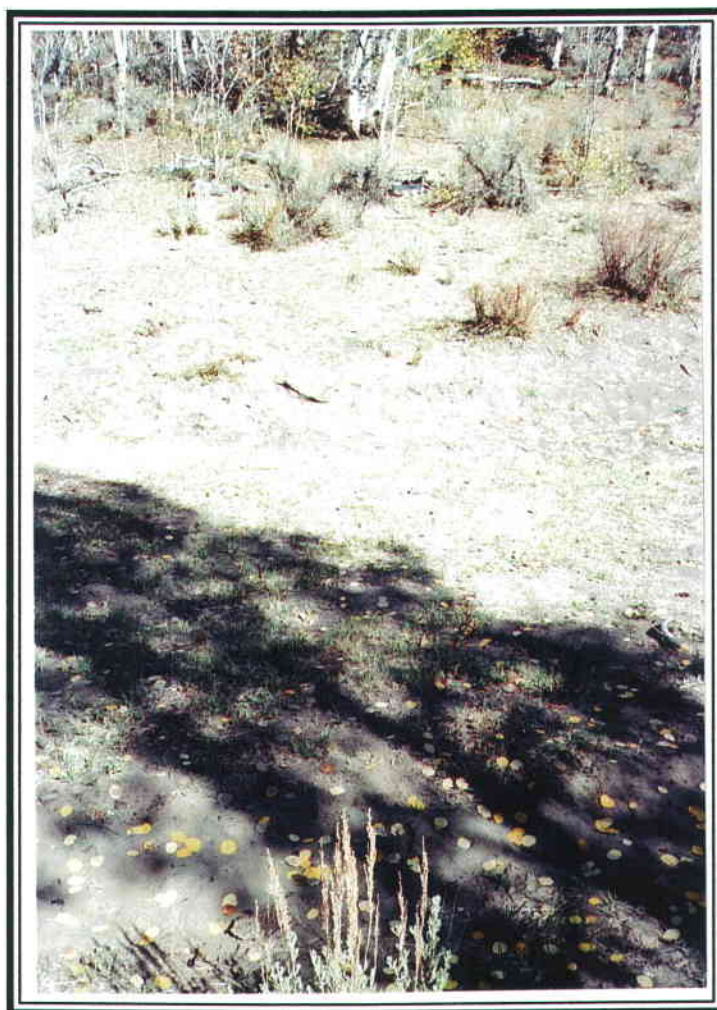
GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-2		Left	13.0	<i>Agrostis stolonifera/Juncus arcticus</i>
		Right	13.0	<i>Agrostis stolonifera/Juncus arcticus</i>
		Channel	22.0	Upland

EFB-2: Cover using point quadrats (October 2008).

COVER BY SPECIES	PERCENT
TREES & SHRUBS	
<i>Artemisia tridentata</i>	6.25
FORBS	
<i>Achillea millefolium</i>	6.25
<i>Erigeron divergens</i>	12.50
GRASSES/GRASS-LIKES	
<i>Agrostis stolonifera</i>	6.25
<i>Juncus arcticus</i>	6.25
<i>Poa pratensis</i>	12.50
TOTAL COVER	
LIVING COVER (vascular)	50.00
STREAM	0.00
MOSS	0.00
LITTER	25.00
B/G	25.00
ROCK	0.00
TOTAL	100.00

PHOTOGRAPHIC DOCUMENTATION



EFB-2

RIPARIAN COMPLEX DATA SHEET

October 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-3

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: October 6-9, 2008

OBSERVER(S): P. Collins; S. Vlietstra

QUAD NAME: Emery West, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: NW

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 2^\circ$

ELEVATION: 8,360 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Aspen

Right: Aspen/Ponderosa Pine

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: seral to climax (but recent years' upper bank movement influences status).

APPARENT FORAGE TREND: unstable

ESTIMATED FORAGE PRODUCTION: 250 lbs./ac

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Pinus ponderosa</i>	<i>Artemisia tridentata</i>	<i>Equisetum arvense</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>		<i>Lepidium latifolia</i>	<i>Carex lanuginosa</i>
		<i>Taraxacum officinale</i>	<i>Juncus arcticus</i>
		<i>Eriogonum sp.</i>	<i>Poa fendleriana</i>
		<i>Lupinus sp.</i>	<i>Poa pratensis</i>
		<i>Artemisia dracunculus</i>	
		<i>Penstemon sp.</i>	

POOL ATTRIBUTES

% area in pools: n/a (no water in the channel at this location)

% pool area made up of pools > 2' deep: n/a (no water in the channel at this location)

AQUATIC VEGETATION

% streambed with filamentous algae: n/a (no water in the channel at this location)

% stream margin with rooted aquatic: n/a (no water in the channel at this location)

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°):

% bank length with overhanging vegetation: 0

BANK CONDITION

% bank length vegetated, stable: 50

% bank length unvegetated, stable: 25

% bank length vegetated, unstable: 10

% bank length unvegetated, unstable: 15

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) Quantitative Methods: Point quadrats; sampled at 3 ft. intervals; 24 ft. transect on left side; 24 ft. transect on right side. (48 ft; includes uplands).

2) Grazed by cattle this year.

- 3) Dry, no water.
- 4) Cattle trail in left side of riparian vegetation may influence green line measurements.
- 5) Erosion occurring on right side from overland surface water perpendicular to stream channel.
- 6) There were signs of recent flooding; sandy banks were quite unstable.
- 7) Riparian spp. seemed to be more prevalent above what I measured as the stream riparian plants. In other words, they were on side areas and maybe were uninfluenced by bottomland riparian water zone.

DATA SUMMARIES

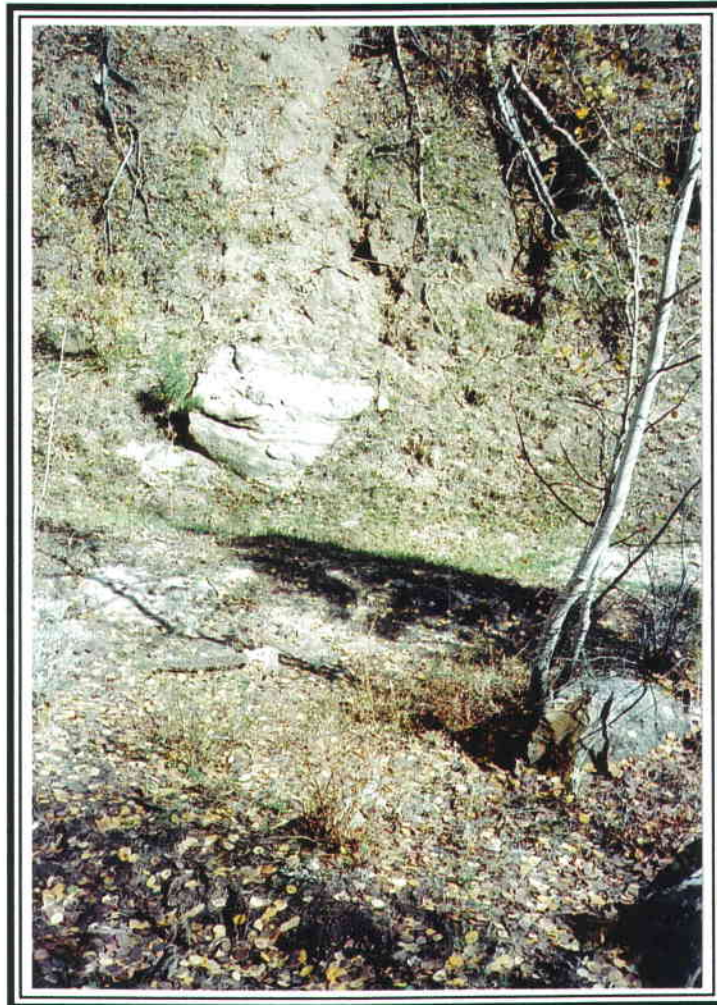
GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-3		Left	5.0	<i>Agrostis stolonifera</i> / <i>Carex lanuginosa</i>
		Right	4.0	<i>Agrostis stolonifera</i> / <i>Carex lanuginosa</i>
		Channel	n/a	Dry, but vegetated

EFB-3: Cover using point quadrats (October 2008).

COVER BY SPECIES	PERCENT
TREES & SHRUBS	
<i>Artemisia tridentata</i>	6.25
FORBS	
GRASSES/GRASS-LIKES	
<i>Agrostis stolonifera</i>	6.25
<i>Carex lanuginosa</i>	6.25
<i>Poa pratensis</i>	6.25
TOTAL COVER	
LIVING COVER (vascular)	25.00
WATER	0.00
MOSS	0.00
LITTER	31.25
B/G	43.75
ROCK	0.00
TOTAL	100.00

PHOTOGRAPHIC DOCUMENTATION



EFB-3

RIPARIAN COMPLEX DATA SHEET
October 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-4

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: October 6-9, 2008

OBSERVER(S): P. Collins; S. Vlietstra

QUAD NAME: Emery West, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: N

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 3^{\circ}$

ELEVATION: 8,355 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Ponderosa Pine/Aspen

Right: Aspen/Ponderosa Pine

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: seral (but recent years' upper bank movement could influence status).

APPARENT FORAGE TREND: More stable than last period.

ESTIMATED FORAGE PRODUCTION: 200 lbs./ac

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Artemisia tridentata</i>	<i>Antennaria sp.</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Chrysothamnus nauseosus</i>	<i>Equisetum arvense</i>	<i>Juncus arcticus</i>
<i>Pinus ponderosa</i>	<i>Potentilla fruticosa</i>		<i>Poa fendleriana</i>
	<i>Rosa woodsii</i>		<i>Poa pratensis</i>
			<i>Poa secunda</i>
			<i>Carex lanuginosa</i>

POOL ATTRIBUTES

% area in pools: Dry

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 5 (dry trail)

% bank length with overhanging vegetation: 5

BANK CONDITION

% bank length vegetated, stable: 30

% bank length unvegetated, stable: 35

% bank length vegetated, unstable: 5

% bank length unvegetated, unstable: 30

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) Quantitative Methods: Point quadrats; sampled at 3 ft. intervals; 24 ft. transect on left side; 24 ft. transect on right side (48 ft; includes uplands).

2) No water was present at site, but in July 2006 a very large storm event forced me to leave the site. Flooding and severe bank erosion occurred at that time. I later learned the storm event was >1.20" of precipitation in less than 1 hour. Also, another 1.79" evidently occurred one day after I

left the area.

3) Lots of grazing by cattle and wildlife observed for this sample period here.

4) The site has been dry and rather bare recently, but it looks like sedges are beginning to become established on the sandy bottoms.

5) There was side-slope erosion that had occurred, but the vegetation was holding quite well.

DATA SUMMARIES

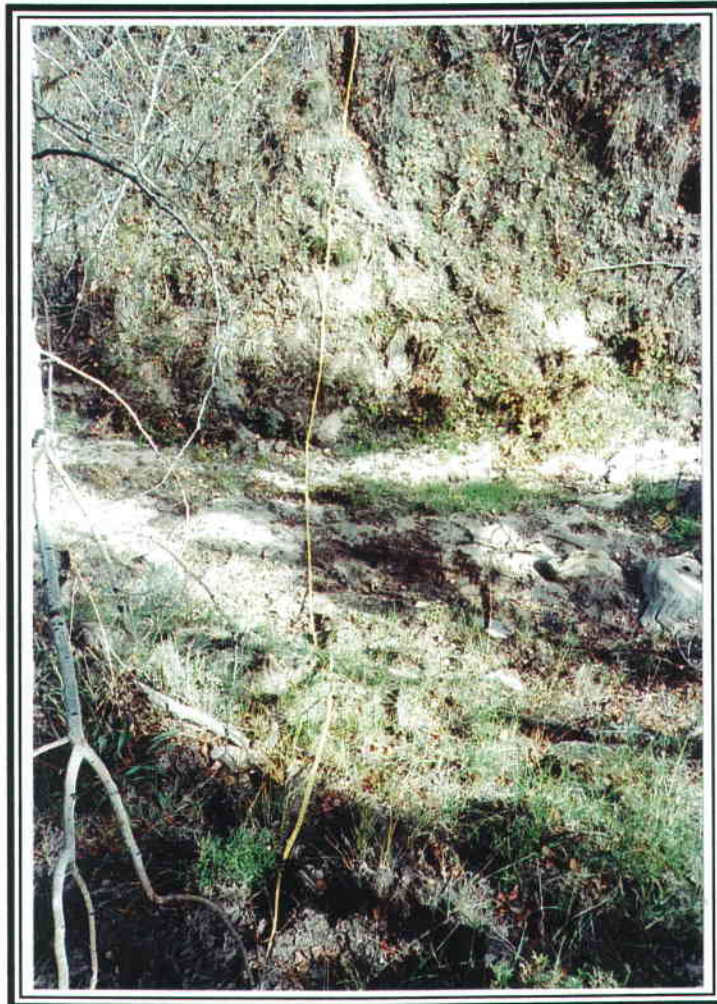
GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-4		Left	3.0	<i>Agrostis stolonifera</i> / <i>Carex lanuginosa</i> / <i>Juncus arcticus</i>
		Right	3.0	<i>Agrostis stolonifera</i> / <i>Carex lanuginosa</i> / <i>Juncus arcticus</i>
		Channel		above includes vegetated dry channel

EFB-4: Cover using point quadrats (October 2008).

COVER BY SPECIES	PERCENT
TREES & SHRUBS	
<i>Rosa woodsii</i>	6.25
FORBS	
<i>Antennaria</i> sp.	12.50
GRASSES/GRASS-LIKES	
<i>Agrostis stolonifera</i>	6.25
<i>Juncus arcticus</i>	6.25
<i>Poa pratensis</i>	12.50
<i>Poa secunda</i>	6.25
TOTAL COVER	
LIVING COVER (vascular)	50.00
WATER	0.00
MOSS	0.00
LITTER	12.50
B/G	37.50
ROCK	0.00
TOTAL	100.00

PHOTOGRAPHIC DOCUMENTATION



EFB-4

RIPARIAN COMPLEX DATA SHEET

October 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-5

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: October 6-9, 2008

OBSERVER(S): P. Collins; S. Vlietstra

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: N

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 2^{\circ}$

ELEVATION: 8,320 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Aspen

Right: Ponderosa Pine/Aspen

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: climax (but recent years' upper bank movement could influence status).

APPARENT FORAGE TREND: moderately unstable

ESTIMATED FORAGE PRODUCTION: 100 lbs./ac

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: *Yes*

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Artemisia tridentata</i>	<i>Antennaria sp.</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Potentilla fruticosa</i>	<i>Lupinus sp.</i>	<i>P. secunda</i>
<i>Pinus ponderosa</i>	<i>Rosa woodsii</i>	<i>Castilleja exilis</i>	<i>P. pratensis</i>
	<i>Salix exigua</i>	<i>Penstemon sp.</i>	<i>Stipa hymenoides</i>
	<i>Symphoricarpos oreophilus</i>	<i>Artemisia ludoviciana</i>	<i>Bouteloua gracilis</i>
	<i>Chrysothamnus nauseosus</i>		

POOL ATTRIBUTES

% area in pools: n/a (no water in this area)

% pool area made up of pools > 2' deep: n/a

AQUATIC VEGETATION

% streambed with filamentous algae: n/a (no water in this area)

% stream margin with rooted aquatic: n/a (no water in this area)

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 0 (but close to 135°)

% bank length with overhanging vegetation: 1%

BANK CONDITION

% bank length vegetated, stable: 15

% bank length unvegetated, stable: 5

% bank length vegetated, unstable: 10

% bank length unvegetated, unstable: 70

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

- 1) Side slopes (above bankfull) were very sandy and unstable.
- 2) Quantitative Methods: Point quadrats; sampled at 3 ft. intervals; 24 ft. transect on left side; 24 ft. transect on right side (48 ft; includes uplands).
- 3) No water in channel in this location.

4) Right side may have some side-slope water influence. There was some young coyote willow becoming established here.

DATA SUMMARIES

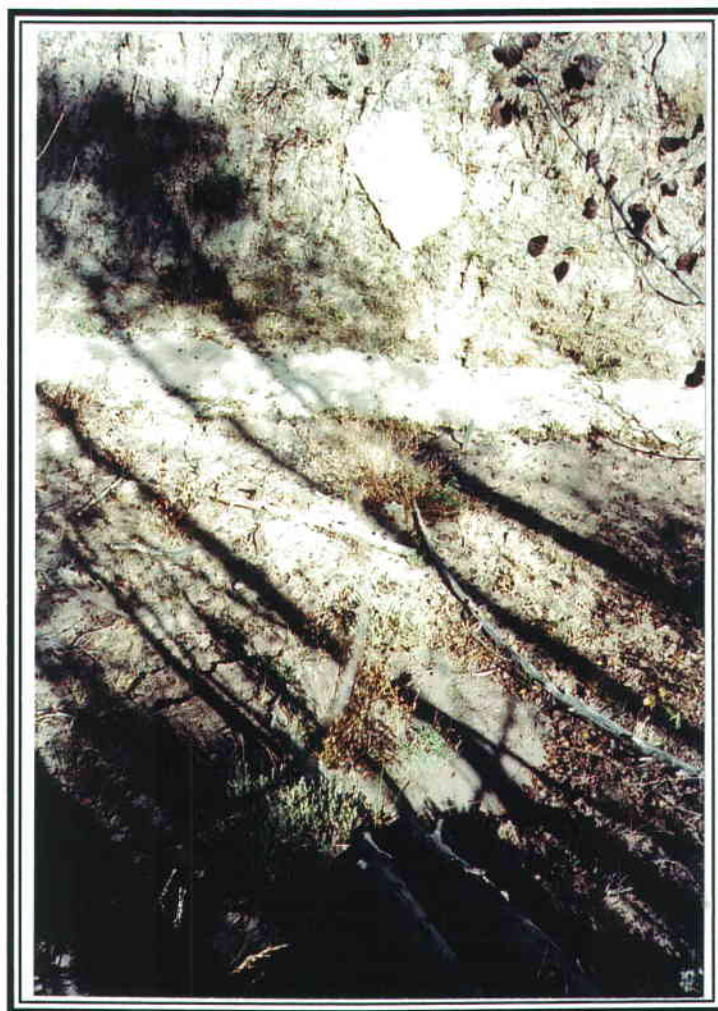
GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-5		Left	2.0	<i>Agrostis stolonifera</i> / <i>Salix exigua</i>
		Right	4.5	<i>Agrostis stolonifera</i>
		Channel	2.5	Dry, sandy

EFB-5 Cover using point quadrats (October 2008).

COVER BY SPECIES	PERCENT
TREES & SHRUBS	
FORBS	
<i>Artemisia dracunculus</i>	6.25
<i>Lupinus argenteus</i>	6.25
GRASSES/GRASS-LIKES	
<i>Poa pratensis</i>	12.50
<i>Poa secunda</i>	18.75
<i>Stipa hymenoides</i>	6.25
TOTAL COVER	
LIVING COVER (vascular)	50.00
WATER	0.00
MOSS	0.00
LITTER	12.50
B/G	37.50
ROCK	0.00
TOTAL	100.00

PHOTOGRAPHIC DOCUMENTATION



EFB-5

RIPARIAN COMPLEX DATA SHEET
October 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-6

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: October 6-9, 2008

OBSERVER(S): P. Collins; S. Vlietstra

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: N

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 2^{\circ}$

ELEVATION: 8,280 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Aspen/Ponderosa Pine

Right: Pinus ponderosa/Aspen

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: Seral

APPARENT FORAGE TREND: decreasing

ESTIMATED FORAGE PRODUCTION: 100 lbs./ac

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Amelanchier utahensis</i>	<i>Taraxacum officinale</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Potentilla fruticosa</i>	<i>Antennaria sp.</i>	<i>Bromus carinatus</i>
<i>Pinus ponderosa</i>	<i>Symphoricarpos oreophilus</i>	<i>Aster sp.</i>	<i>Juncus arcticus</i>
<i>Populus fremontii</i>	<i>Artemisia tridentata</i>	<i>Gilia aggregata</i>	<i>Poa fendleriana</i>
	<i>Artemisia nova</i>	<i>Artemisia ludoviciana</i>	<i>Elymus trachycaulus</i>
		<i>Equisetum arvense</i>	<i>Poa pratensis</i>
		<i>Achillea millefolium</i>	
		<i>Lupinus sp.</i>	

POOL ATTRIBUTES

% area in pools: Dry

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 50

% bank length gently sloping (>135°): (trail)

% bank length with overhanging vegetation: 10

BANK CONDITION

% bank length vegetated, stable: 20

% bank length unvegetated, stable: 30

% bank length vegetated, unstable: 20

% bank length unvegetated, unstable: 30

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable):
stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) Side slope banks above bankfull unstable.

2) Quantitative Methods: Point quadrats; sampled at 3 ft. intervals; 24 ft. transect on left side; 24 ft. transect on right side (48 ft; includes uplands).

- 3) Some grazing by cattle this period. Dry this October, and no water was just downstream 50' - 70' like in October 2007.
- 4) Lots of bank movement.
- 5) The bottom appeared more sandy and wider than before.

DATA SUMMARIES

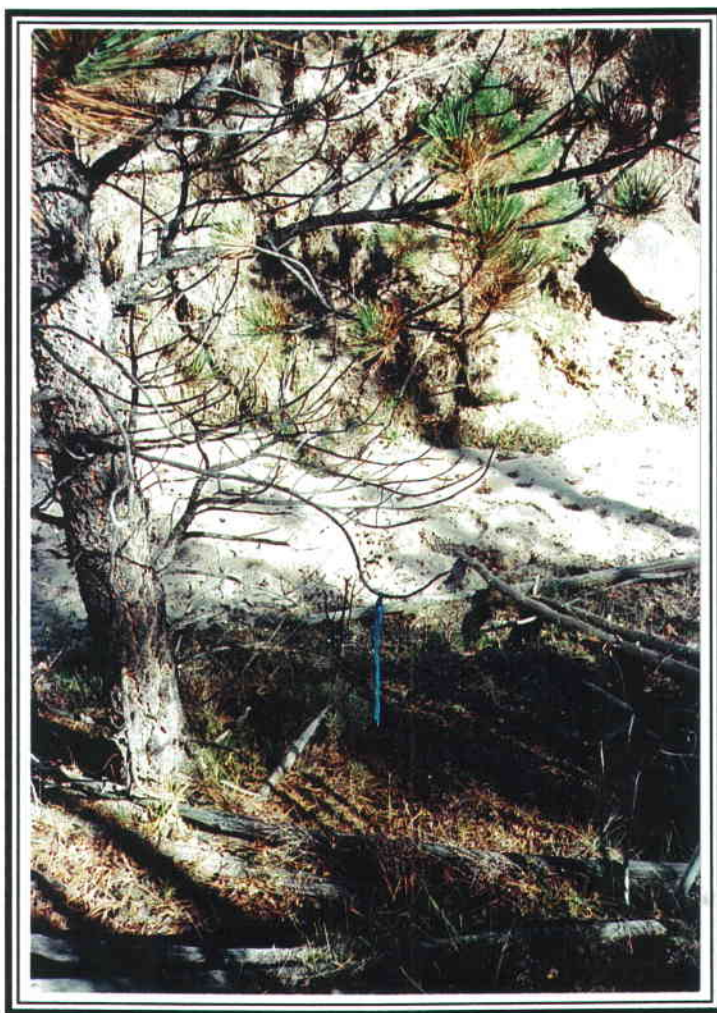
GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-6		Left	4.0	<i>Agrostis stolonifera</i>
		Right	3.0	<i>Agrostis stolonifera</i>
		Channel	6.0	Dry

EFB-6 Cover using point quadrats (October 2008).

COVER BY SPECIES	PERCENT
TREES & SHRUBS	
<i>Artemisia nova</i>	6.25
FORBS	
GRASSES/GRASS-LIKES	
<i>Agrostis stolonifera</i>	6.25
<i>Elymus trachycaulus</i>	6.25
<i>Poa fendleriana</i>	6.25
<i>Poa pratensis</i>	12.50
TOTAL COVER	
LIVING COVER (vascular)	37.50
WATER	0.00
MOSS	0.00
LITTER	31.25
B/G	31.25
ROCK	0.00
TOTAL	100.00

PHOTOGRAPHIC DOCUMENTATION



EFB-6

RIPARIAN COMPLEX DATA SHEET
October 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-7

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: October 6-9, 2008

OBSERVER(S): P. Collins; S. Vlietstra

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: NNW

VALLEY BOTTOM TYPE: I or II

STREAM GRADIENT: $\sim 2^{\circ}$

ELEVATION: 8,270 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Aspen/Spruce

Right: Aspen/Spruce

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: seral

APPARENT FORAGE TREND: Unstable

ESTIMATED FORAGE PRODUCTION: 0 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Juniperus communis</i>	<i>Aster sp.</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Symphoricarpos oreophilus</i>	<i>Artemisia dracunculus</i>	<i>Poa fendleriana</i>
<i>Rosa woodsii</i>		<i>Castilleja sp.</i>	

POOL ATTRIBUTES

% area in pools: no water

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 100 until steep, unstable, upper banks, then 0.

% bank length with overhanging vegetation: 2

BANK CONDITION

% bank length vegetated, stable: 50 undercut rocks

% bank length unvegetated, stable: 0

% bank length vegetated, unstable: 0 (above riparian zone)

% bank length unvegetated, unstable: 0

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

- 1) Water not was present.
- 2) Quantitative Methods: Point quadrats; sampled at 3 ft. intervals; 24 ft. transect on left side; 24 ft. transect on right side (48 ft; includes uplands).
- 3) This was a rock channel now.
- 4) Little or no grazing in this area.
- 5) Much side slope movement on right and left sides.

- 6) This area seemed to have much more bedrock exposed with less soil on left bank along the riparian channel. There was not much of a riparian zone at this site. This may be the result of the several past flood events.
- 7) Aspens have fallen since early data (see photos).
- 8) 11 ft of stream channel (rock); soil and riparian communities appear to have moved by flooding.
- 9) Water was not present this sample period here, but it was running 3 ft downstream. There was no running water above this sample point - only puddles.

DATA SUMMARIES

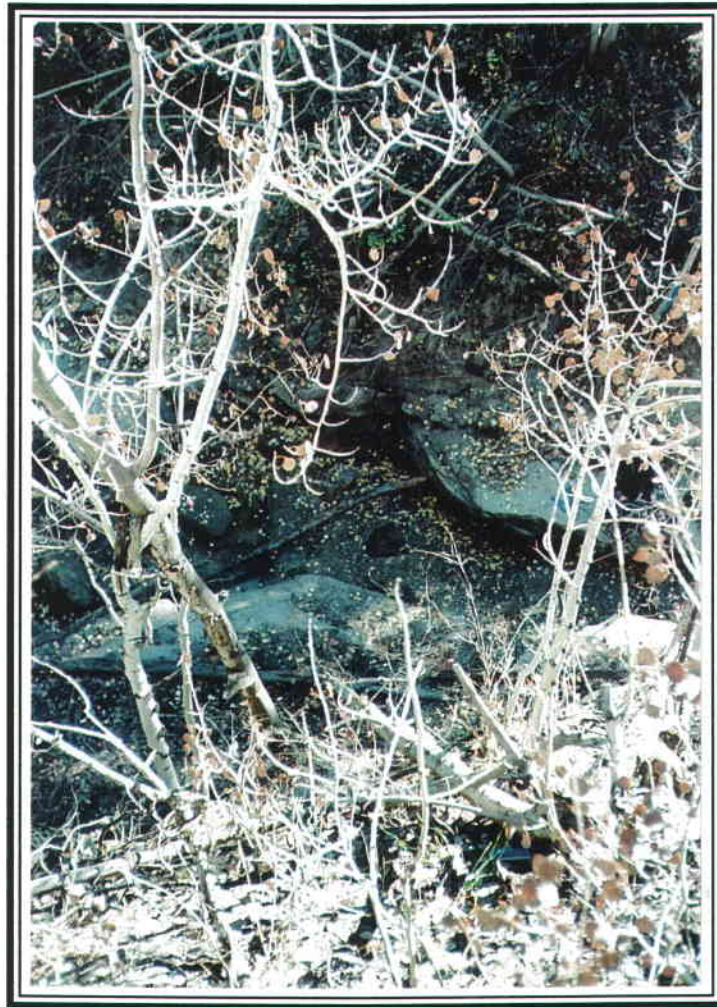
GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-7		Left	0	<i>Agrostis stolonifera</i>
		Right	0	<i>Agrostis stolonifera</i>
		Channel Water	11.0	Rock

EFB-7 Cover using point quadrats (October 2008).

COVER BY SPECIES	PERCENT
TREES & SHRUBS	
<i>Populus tremuloides</i>	6.25
<i>Symphoricarpos oreophilus</i>	
FORBS	
GRASSES/GRASS-LIKES	
<i>Poa pratensis</i>	12.50
TOTAL COVER	
LIVING COVER (vascular)	18.75
WATER	0.00
MOSS	0.00
LITTER	18.75
B/G	37.50
ROCK	25.00
TOTAL	100.00

PHOTOGRAPHIC DOCUMENTATION



EFB-7

RIPARIAN COMPLEX DATA SHEET

October 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-8

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: October 6-9, 2008

OBSERVER(S): P. Collins; S. Vlietstra

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: NNW

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 2^{\circ}$

ELEVATION: 8,265 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Spruce/Aspen

Right: Aspen/Spruce

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: more seral than before now

APPARENT FORAGE TREND: Unstable

ESTIMATED FORAGE PRODUCTION: 0 lbs./ac. in riparian zone.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Symphoricarpos oreophilus</i>	<i>Ranunculus cymbalaria</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>		<i>Achillea millefolium</i>	<i>Poa fendleriana</i>
<i>Pinus ponderosa</i>		<i>Penstemon</i> sp.	<i>P. pratensis</i>
		<i>Antennaria</i> sp.	
		<i>Equisetum arvensis</i>	
		<i>Potentilla</i> sp.	

POOL ATTRIBUTES

% area in pools: 75

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 50, but only sandy sediments.

% bank length with overhanging vegetation: 10

BANK CONDITION (riparian channel)

% bank length vegetated, stable: 0

% bank length unvegetated, stable: 50

% bank length vegetated, unstable: 0

% bank length unvegetated, unstable: 50

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

- 1) Beginning to see more blue spruce and less ponderosa pine in uplands in this area.
- 2) Quantitative Methods: This is a difficult area to monitor because there is a spring on the right side with water flowing from it. The information above is for the main channel.

- 3) For the point quads, the transect crossed the spring community too (transect total = 56 ft; channel erosion increased length from 54 ft). *I did not count the "island" between the two as riparian* (but I may have previously). For both separate data, see the Green Line method below.
- 4) There was severe flooding impacts here in the July 2006 flood. The bank was down cut ± 3 ft lower than the previous elevations. The small green conifer in the area was downed (compare photographs with previous sample periods). Riparian communities have been impacted by the flooding.
- 5) No cattle sign this year.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-8 Main Channel		Left	0	<i>Equisetum arvensis</i> / <i>Agrostis stolonifera</i>
		Right	0	<i>Equisetum arvense</i>
		Channel	6.0	Water
EFB-8 Spring Channel		Left	1.0	<i>Equisetum arvense</i>
		Right	0.5	<i>Agrostis stolonifera</i>
		Channel	8.0 1.0	Mud Water

EFB-8 Cover using point quadrats (October 2008).

COVER BY SPECIES	PERCENT
TREES & SHRUBS	
<i>Picea pungens</i>	5.88
FORBS	
<i>Equisetum arvense</i>	11.76
GRASSES/GRASS-LIKES	
<i>Agrostis stolonifera</i>	5.88
<i>Poa pratensis</i>	11.76
TOTAL COVER	
LIVING COVER (vascular)	35.29
WATER	17.65
MOSS	0.00
LITTER	17.65
B/G	23.53
ROCK	5.88
TOTAL	100.00

PHOTOGRAPHIC DOCUMENTATION



EFB-8

RIPARIAN COMPLEX DATA SHEET

October 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-9 (RE-10)

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: October 6-9, 2008

OBSERVER(S): P. Collins; S. Vlietstra

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss/Blackhawk Fm

ASPECT: W

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 3^{\circ}$

ELEVATION: 8,240 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Aspen

Right: Spruce/Aspen

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: Seral (recent years' upper bank movement has influenced status).

APPARENT FORAGE TREND: no riparian vegetation present

ESTIMATED FORAGE PRODUCTION: 0

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Ribes sp.</i>	<i>Equisetum arvensis</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Rosa woodsii</i>		
<i>Salix amygdaloides</i>	<i>Symphoricarpos oreophilus</i>		

POOL ATTRIBUTES

% area in pools: 50

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 50

% bank length gently sloping (>135°): 0

% bank length with overhanging vegetation: 35

BANK CONDITION

% bank length vegetated, stable: 0

% bank length unvegetated, stable: 50

% bank length vegetated, unstable: 0

% bank length unvegetated, unstable: 50

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable (left side)/unstable (right side)

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) Bank cut on right and left sides.

2) Quantitative Methods: Point quadrats; sampled at 3 ft. intervals for 30 ft. (see below).

In addition, the USDA Forest Service Protocol for Level III was employed by measuring the plant communities using the line intercept method.

3) Lots of grazing by cattle this year above and below this site.

4) For point quadrats we had different transect lengths: Oct 03 (50 ft), July 04 (50 ft), Oct 04 (32 ft or 38 ft); subsequent measurements (38'). This is probably because there were two transects marked in the field because we also utilized transects from our 1999 study which were different than the one's marked by the team for the more recent studies. *Note that comparisons of these data can be confusing because pt. quad transects were sometimes different than line transects.*

5) I used the two inside stakes this period (now 30 ft apart).

4) Floods mentioned earlier basically eliminated the riparian zone at this site.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-9	RE-10	Left	0	<i>Equisetum arvense</i>
		Right	0	<i>Equisetum arvense</i>
		Channel	2.0 6.0	Water Rock

RE-10 (EFB-9) Cover using point quadrats (October 2008).

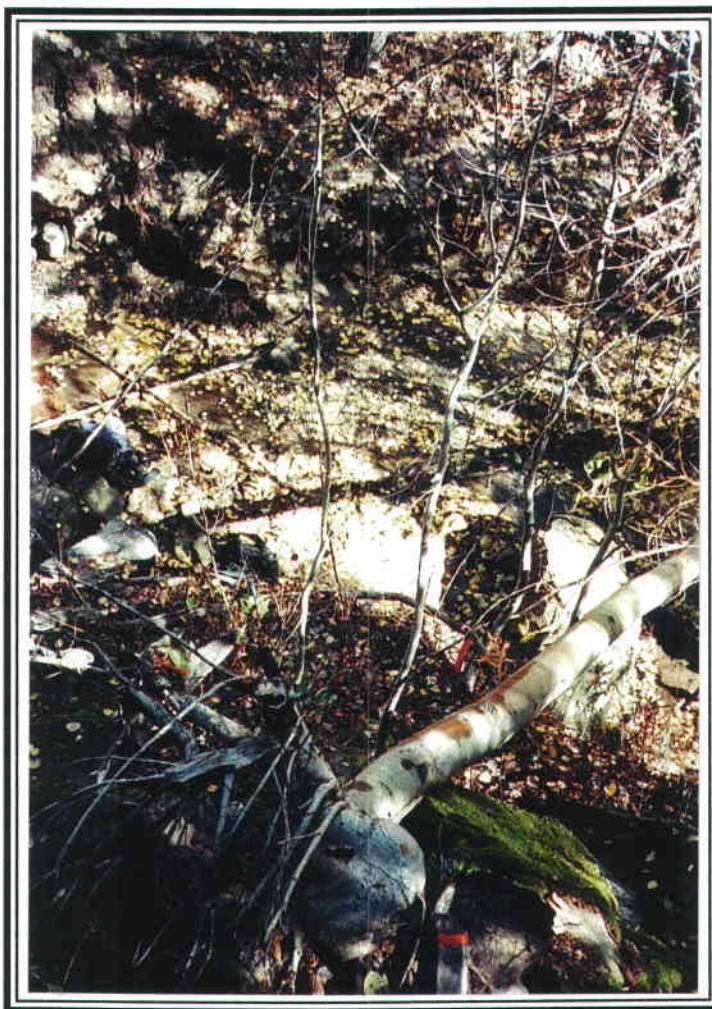
COVER BY SPECIES	PERCENT
TREES & SHRUBS	
<i>Rosa woodsii</i>	8.33
FORBS	
GRASSES/GRASS-LIKES	
TOTAL COVER	
LIVING COVER (vascular)	8.33
WATER	8.33
MOSS	25.00
LITTER	16.67
B/G	16.67
ROCK	25.00
TOTAL	100.00

RE-10: Cover by community types in Box Canyons (October 2008)

USDA Forest Service Protocol (1992)

	Cover (ft)
UPLAND VEGETATION	
<i>Populus tremuloides/Picea pungens</i>	21.00
<i>Populus tremuloides/Rosa woodsii</i>	8.00
RIPARIAN VEGETATION	
<u>Dominant Woody Species</u>	
<u>Dominant Herbaceous Species</u>	
<i>Agrostis stolonifera</i>	0.00
TOTAL COVER (Upland Species)	29.00
TOTAL COVER (Riparian Species)	0.00
BAREGROUND/LITTER	1.00
ROCK	6.00
WATER/MUD/DRY CHANNEL	2.00
MOSS	0.00
TOTAL COVER	38.00

PHOTOGRAPHIC DOCUMENTATION



EFB-9 (RE-10)

RIPARIAN COMPLEX DATA SHEET

October 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-10 (RE-09)

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: October 6-9, 2008

OBSERVER(S): P. Collins; S. Vlietstra

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Blackhawk

ASPECT: N

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 3^{\circ}$

ELEVATION: 8,120 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%

MORE SOILS INFORMATION:

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Spruce

Right: Spruce/Aspen

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: Unstable.

APPARENT FORAGE TREND: Decreasing

ESTIMATED FORAGE PRODUCTION: 50 lbs./ac

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Salix sp.</i>	<i>Ranunculus cymbalaria</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Rosa woodsii</i>	<i>Geranium richardsonii</i>	<i>Poa pratensis</i>
<i>Betula occidentalis</i>		<i>Equisetum arvense</i>	
		<i>Epilobium angustifolium</i>	
		<i>Galium aparine</i>	

POOL ATTRIBUTES

% area in pools: 50

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 10

% bank length gently sloping (>135°): 50

% bank length with overhanging vegetation: 10

BANK CONDITION

% bank length vegetated, stable: 4

% bank length unvegetated, stable: 40

% bank length vegetated, unstable: 3

% bank length unvegetated, unstable: 53

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

- 1) Just beginning to see river birch in this area.
- 2) Quantitative Methods: There were two transect lines here because of the older (1999) study. One was 28 ft (from 1999) and one was 36 ft (team study). For point quadrats for Oct 2005, we sampled at 3 ft. intervals for the 28 ft transect line. I also sampled on 36 ft line (left in raw data). Regarding the two pt. quad transect lines (28 ft and 36 ft) for July 2006 and Oct 2006, we also sampled the 36 ft line in July and October 2008.
In addition, the USDA Forest Service Protocol for Level III was employed by measuring the plant communities using the line intercept method (I used a 36 ft transect line in Oct 2005 and July 2006 which was *not consistent with July 2005*).
- 3) Right hillside suggests (by presence of horsetail) that there is probably a lot of soil moisture in the spring and early summer. No water in hillside observed
- 4) Water at site; waterfall is above this station.
- 5) Photo taken from left side.
- 6) Negligible grazing by cattle this year.
- 7) There was lots of bareground that I counted in the upland community.
- 8) There were some small live blue spruce trees downed due to flooding and side slope movement.
- 9) Very unstable area at this time.
- 10) I believe this is one of D. Shiozawa's macroinvertebrate sampling sites.
- 11) The flood in July 2006 took most of the riparian zone on the left side.
- 12) No riparian community observed; there were some roots observed from the hillside vegetation.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

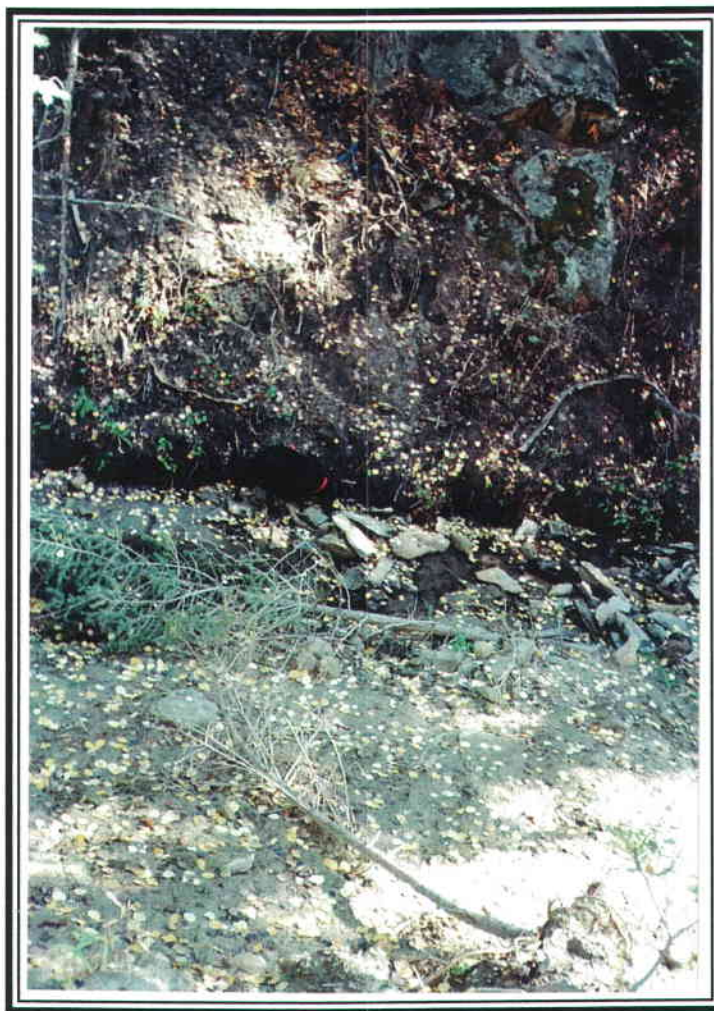
Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-10	RE-09	Left	0.0	<i>Equisetum arvense</i> / <i>Geranium richardsonii</i>
		Right	1.0	<i>Equisetum arvense</i>
		Channel	3.0 4.0	Water Rock

RE-9 (EFB-10) Cover using point quadrats (October 2008).	
COVER BY SPECIES	PERCENT
TREES & SHRUBS	
FORBS	
<i>Galium aparine</i>	8.33
GRASSES/GRASS-LIKES	
TOTAL COVER	
LIVING COVER (vascular)	8.33
WATER	16.67
MOSS	0.00
LITTER	8.33
B/G	53.33
ROCK	8.33
TOTAL	100.00

RE-09: Cover by community types in Box Canyons (October 2008)

USDA Forest Service Protocol (1992)	
	Cover (ft)
UPLAND VEGETATION	
<i>Populus tremuloides</i>	28.00
RIPARIAN VEGETATION	
<u>Dominant Woody Species</u>	
<u>Dominant Herbaceous Species</u>	
<i>Equisetum arvensis</i>	1.00
TOTAL COVER (Upland Species)	28.00
TOTAL COVER (Riparian Species)	1.00
BAREGROUND/LITTER	0.00
ROCK	4.00
WATER/MUD/DRY CHANNEL	3.00
MOSS	0.00
TOTAL COVER	36.00

PHOTOGRAPHIC DOCUMENTATION



EFB-10 (RE-09)

RIPARIAN COMPLEX DATA SHEET

October 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-11

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: October 6-9, 2008

OBSERVER(S): P. Collins; S. Vlietstra

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Blackhawk Fm

ASPECT: NW

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 3^{\circ}$

ELEVATION: 8,120 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%

MORE SOILS INFORMATION:

- Soil Map Unit No. 20
- Family: Strych
- Composition:
 - Strych Family Soils: 30 %
 - Pathead Family Soils: 30%
 - Podo Family Soils: 15%
 - Rubbleland: 15%
 - Contrasting inclusions of rock outcrops, and finer textured soils: 10%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Spruce/Aspen

Right: Spruce/Aspen

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: Unstable due to recent flooding.

APPARENT FORAGE TREND: Decreasing

ESTIMATED FORAGE PRODUCTION: 20 lbs/ac. (including woody species)

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Pachystima myrsinites</i>	<i>Cirsium sp.</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Symphoricarpos oreophilus</i>	<i>Geranium richardsonii</i>	<i>Juncus longistylis</i>
<i>Salix sp.</i>		<i>Equisetum arvense</i>	<i>Poa fendleriana</i>
<i>Cornus sericea</i>			
<i>Betula occidentalis</i>			

POOL ATTRIBUTES

% area in pools: 50

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 0

% bank length with overhanging vegetation: 20

BANK CONDITION

% bank length vegetated, stable: 5

% bank length unvegetated, stable: 45

% bank length vegetated, unstable: 5

% bank length unvegetated, unstable: 45

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

- 1) This site is just below the confluence of a spring (EFB-S1)
- 2) Quantitative Methods: Point quadrats; sampled at 3 ft. intervals on a 45 ft transect line.
- 3) Little or no grazing by cattle this year.
- 4) Flood took down or pushed over mature trees just upstream from sample site including river birch, willow, and dogwood (photographs taken for files in July and October 2006).
- 5) Most of the riparian zone was eliminated from flooding.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-11		Left	1.0	<i>Agrostis stolonifera</i> / <i>Carex lanuginosa</i>
		Right	0.5	<i>Agrostis stolonifera</i> / <i>Equisetum arvense</i>
		Channel	2.0 2.0	Water Rock

EFB-11 Cover using point quadrats (October 2008).

COVER BY SPECIES	PERCENT
TREES & SHRUBS	
FORBS	
<i>Equisetum arvense</i>	6.67
<i>Geranium richardsonii</i>	6.67
GRASSES/GRASS-LIKES	
TOTAL COVER	
LIVING COVER (vascular)	13.33
WATER	13.33
MOSS	6.67
LITTER	13.33
B/G	40.00
ROCK	13.33
TOTAL	100.00

PHOTOGRAPHIC DOCUMENTATION



EFB-11

RIPARIAN COMPLEX DATA SHEET

October 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-S1

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: October 6-9, 2008

OBSERVER(S): P. Collins; S. Vlietstra

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Blackhawk Fm

ASPECT: W

VALLEY BOTTOM TYPE: II

STREAM (SLOPE) GRADIENT: ~28°

ELEVATION: 8,120 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 20
- Family: Strych
- Composition:
 - Strych Family Soils: 30 %
 - Pathead Family Soils: 30%
 - Podo Family Soils: 15%
 - Rubbleland: 15%
 - Contrasting inclusions of rock outcrops, and finer textured soils: 10%

MORE SOILS INFORMATION:

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Spruce/Aspen

Right: Spruce/Aspen

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: seems more stable now.

APPARENT FORAGE TREND: *stable*

ESTIMATED FORAGE PRODUCTION: 500 lbs./ac.

BEAVER ACTIVITY: *none observed*

PHOTOGRAPH TAKEN: *Yes*

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: *Mining, grazing, hunting, recreation.*

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Salix sp.</i>	<i>Equisetum arvense</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Symphoricarpos oreophilus</i>	<i>Ranunculus cymbalaria</i>	<i>Carex lanuginosa</i>
	<i>Rosa woodsii</i>	<i>Aster sp.</i>	<i>Elymus trachycaulus</i>
	<i>Lonicera involucrata</i>	<i>Geranium richardsonii</i>	<i>Juncus arcticus</i>
	<i>Betula occidentalis</i>		<i>Bromus carinatus</i>

POOL ATTRIBUTES

% area in pools: 50

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 30 (of wet area studied)

% bank length with overhanging vegetation: 10 (but increases above this area)

BANK CONDITION

% bank length vegetated, stable: 65

% bank length unvegetated, stable: 35

% bank length vegetated, unstable: 0

% bank length unvegetated, unstable: 0 (left bank above green)

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): *stable*

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) A spring area, it is located about 50 ft. above confluence with the main channel of East Fork of Box Canyon.

2) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method.

- 3) Original stakes were gone. I put blue flagging and made a 37 ft transect line in Oct 2005; I used this line for the remainder of the sample periods.
- 4) Water in spring seems to be increasing compared to the last two sample periods. The spring water seems to have increased its flow.
- 5) More riparian vegetation becoming established here.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

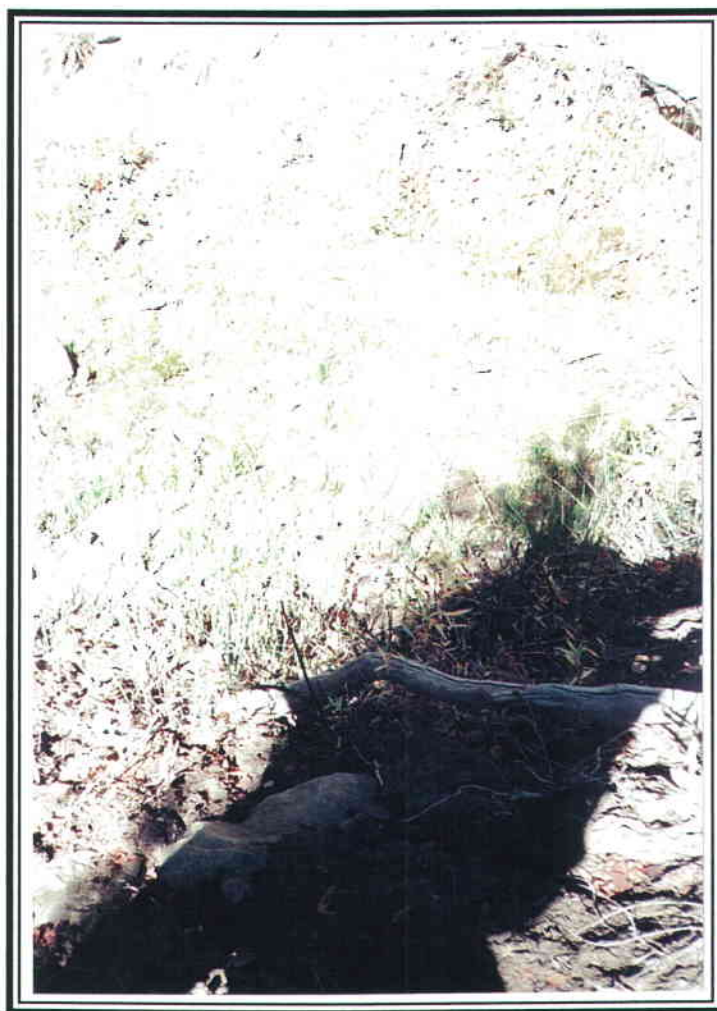
Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-S1		Left	11.0	<i>Equisetum arvense/Ranunculus cymbalaria/Carex lanuginosa</i>
		Right	9.0	<i>Equisetum arvense/Ranunculus cymbalaria/Carex lanuginosa</i>
		Channel	1.0	Water

EFB-S1: Cover by community types in Box Canyons (October 2008)

USDA Forest Service Protocol (1992)

	Cover (ft)
UPLAND VEGETATION	
<i>Aster/Bareground</i>	12.00
<i>Bromus carinatus</i>	4.00
RIPARIAN VEGETATION	
<u>Dominant Woody Species</u>	
<u>Dominant Herbaceous Species</u>	
<i>Carex lanuginosa/Ranunculus cymbalaria</i>	6.00
<i>Equisetum arvensis</i>	14.00
TOTAL COVER (Upland Species)	16.00
TOTAL COVER (Riparian Species)	20.00
BAREGROUND/LITTER	0.00
ROCK	0.00
WATER/MUD/DRY CHANNEL	1.00
MOSS	0.00
TOTAL COVER	37.00

PHOTOGRAPHIC DOCUMENTATION



EFB-S1

RIPARIAN COMPLEX DATA SHEET

October 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-S2 (EFB-12)

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: October 6-9, 2008

OBSERVER(S): P. Collins; S. Vlietstra

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss/Blackhawk Fm

ASPECT: W

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: ~30°

ELEVATION: 8,200 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%

MORE SOILS INFORMATION:

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: *Picea pungens*

Right: *Picea pungens*

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: Not climax, unstable.

APPARENT FORAGE TREND: Seems to be stabilizing

ESTIMATED FORAGE PRODUCTION: 500 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Juniperus communis</i>	<i>Ranunculus cymbalaria</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>		<i>Equisetum arvense</i>	<i>Carex lanuginosa</i>
<i>Lonicera involucrata</i>		<i>Geranium richardsonii</i>	
<i>Betula occidentalis</i>			

POOL ATTRIBUTES

% area in pools: 0

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 100

% bank length with overhanging vegetation: 65 (more below or downhill)

BANK CONDITION

% bank length vegetated, stable: 35

% bank length unvegetated, stable: 65

% bank length vegetated, unstable: 0

% bank length unvegetated, unstable: 0

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) This was an area that includes 2 springs near each other. Previous data (Oct. 2003) was taken at the head of the springs; water diffused downslope over a broad area in which data collection would have been difficult and possibly ambiguous.

2) The area was dry again this sample period (Oct. 2005) due to a large sandstone cliff failure and rockslide over the entire spring area. A few riparian species remained, but not many. It's

basically an upland-looking community at this time. Yet some riparian or mesic species may be increasing such as horsetail, sedge and geranium.

3) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method. I found both end stakes on the previous transect line.

Green Line: Also measured on transects.

4) The historical spring still remains mostly absent.

5) Riparian species are mostly absent, but a few remain; they were measured carefully.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-S2	EFB-12	Left	10.0	<i>Equisetum arvense</i>
		Right	3.0	<i>Geranium richardsonii/Equisetum arvense</i>
		Channel	n/a	

EFB-S2: Cover by community types in Box Canyons (October 2008)

USDA Forest Service Protocol (1992)

Cover (ft)

UPLAND VEGETATION

Populus tremuloides 58.00

RIPARIAN VEGETATION

Dominant Woody Species

Dominant Herbaceous Species

Geranium richardsonii/Equisetum arvense 13.00

TOTAL COVER (Upland Species) 58.00

TOTAL COVER (Riparian Species) 13.00

BAREGROUND/LITTER 0.00

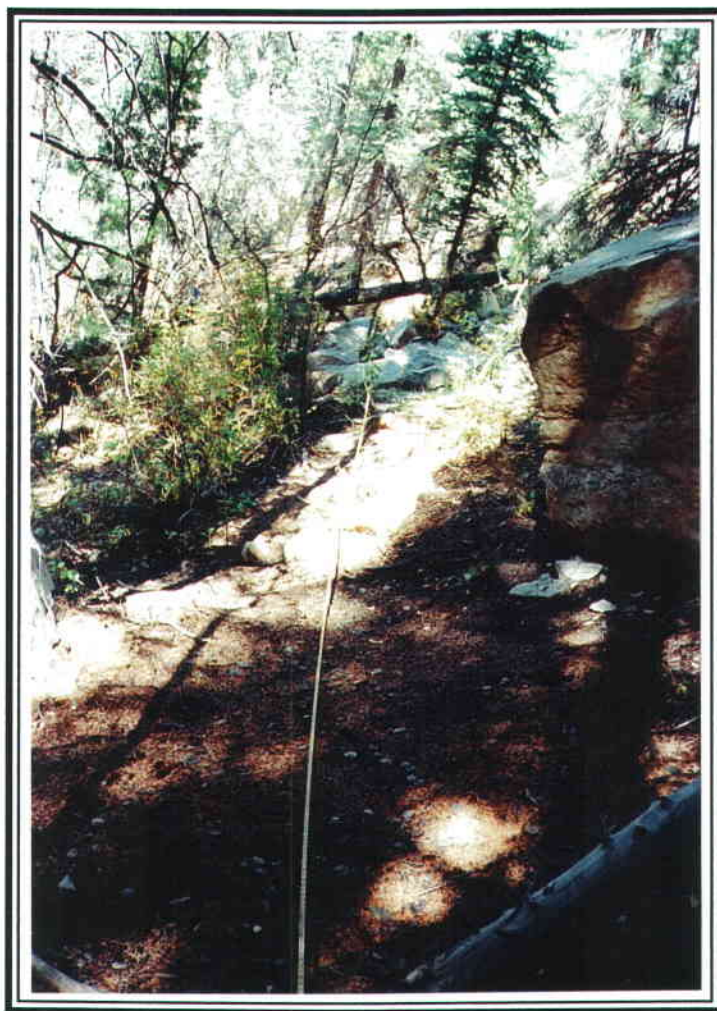
ROCK 8.00

WATER/MUD/DRY CHANNEL 0.00

MOSS 0.00

TOTAL COVER 79.00

PHOTOGRAPHIC DOCUMENTATION



EFB-S2 (EFB-12)

RIPARIAN COMPLEX DATA SHEET

October 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-S3 - North & South (EFB-13)

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: October 6-9, 2008

OBSERVER(S): P. Collins; S. Vlietstra

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss/Blackhawk Fm

ASPECT: W

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: ~2-30°

ELEVATION: 8,245 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%

MORE SOILS INFORMATION:

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Ponderosa Pine

Right: Ponderosa Pine

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: Unstable, no longer considered "climax".

APPARENT FORAGE TREND: Seems more stable now.

ESTIMATED FORAGE PRODUCTION: 250 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Symphoricarpos oreophilus</i>	<i>Equisetum arvense</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Juniperus communis</i>	<i>Geranium richardsonii</i>	<i>Elymus trachycaulus</i>
<i>Pinus ponderosa</i>	<i>Rosa woodsii</i>		
<i>Salix amygdaloides</i>			
<i>Cornus stolonifera</i>			

POOL ATTRIBUTES

% area in pools: 0

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 100

% bank length with overhanging vegetation: 60

BANK CONDITION (North/South)

% bank length vegetated, stable: 5

% bank length unvegetated, stable: 95

% bank length vegetated, unstable: 0

% bank length unvegetated, unstable: 0

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method. Green Line: Also measured on these transects.

- 2) I found the line stakes. I measured north S3 (30 ft) and south S3 (31 ft) separately.
- 3) This spring area has gone dry.
- 4) Riparian species present but decreased since October 2003; seem at equilibrium now.
- 5) There were wetland/riparian species (see Green Line data).
- 6) The understory in the area was mostly bareground.
- 7) Difficult to call data here; almost no riparian species left here.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

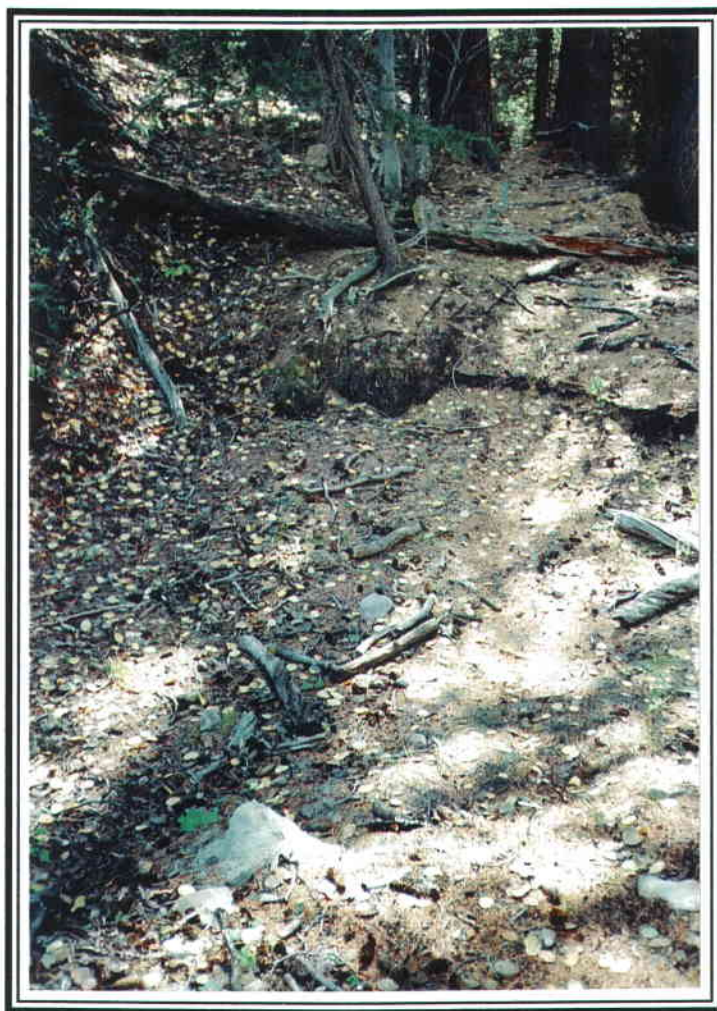
Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-S3	EFB-13	North	1.0	<i>Agrostis stolonifera</i>
		South	0.0	
		Channel	n/a	

EFB-S3: Cover by community types in Box Canyons (October 2008)

USDA Forest Service Protocol (1992)

	Cover (ft)
UPLAND VEGETATION	
<i>Populus tremuloides/Picea pungens</i>	60.00
RIPARIAN VEGETATION	
<u>Dominant Woody Species</u>	
<u>Dominant Herbaceous Species</u>	
<i>Agrostis stolonifera/Ranunculus cymbalaria</i>	1.00
TOTAL COVER (Upland Species)	60.00
TOTAL COVER (Riparian Species)	1.00
BAREGROUND/LITTER	0.00
ROCK	0.00
WATER/MUD/DRY CHANNEL	0.00
MOSS	0.00
TOTAL COVER	61.00

PHOTOGRAPHIC DOCUMENTATION



EFB-S3 (EFB-13) South

RIPARIAN COMPLEX DATA SHEET

October 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number EFB-S4 (EFB-14)

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: October 6-9, 2008

OBSERVER(S): P. Collins; S. Vlietstra

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss/Blackhawk Fm

ASPECT: W

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: ~25°

ELEVATION: 8,240 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%

MORE SOILS INFORMATION:

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Horsetail (uphill)/Spruce

Right: Horsetail (uphill)/Spruce

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: not climax.

APPARENT FORAGE TREND: Unstable

ESTIMATED FORAGE PRODUCTION: 100 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Symphoricarpos oreophilus</i>	<i>Geranium richardsonii</i>	<i>Festuca ovina</i>
<i>Populus tremuloides</i>	<i>Potentilla fruticosa</i>	<i>Equisetum arvense</i>	
<i>Salix amygdaloides</i>	<i>Rosa woodsii</i>		

POOL ATTRIBUTES

% area in pools: 0 (no water present)

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 0

% bank length with overhanging vegetation: 65

BANK CONDITION

% bank length vegetated, stable: 30

% bank length unvegetated, stable: 30

% bank length vegetated, unstable: 10

% bank length unvegetated, unstable: 30

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) Spring area. There was a seep here during the first sample period (Oct 2003). It was dry leaving bareground for last sample periods. Some riparian species remain. The entire transect area was dominated by horsetail with some redtop (last sample period, July '08), this sample period seemed to show less of these species (Oct '08).

- 2) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method. Green Line: Also measured on these transects.
3) I'm not sure why the transect measures 19 ft this sample period, while other times it measured 25 ft. *Measured 19 ft this sample period.*

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

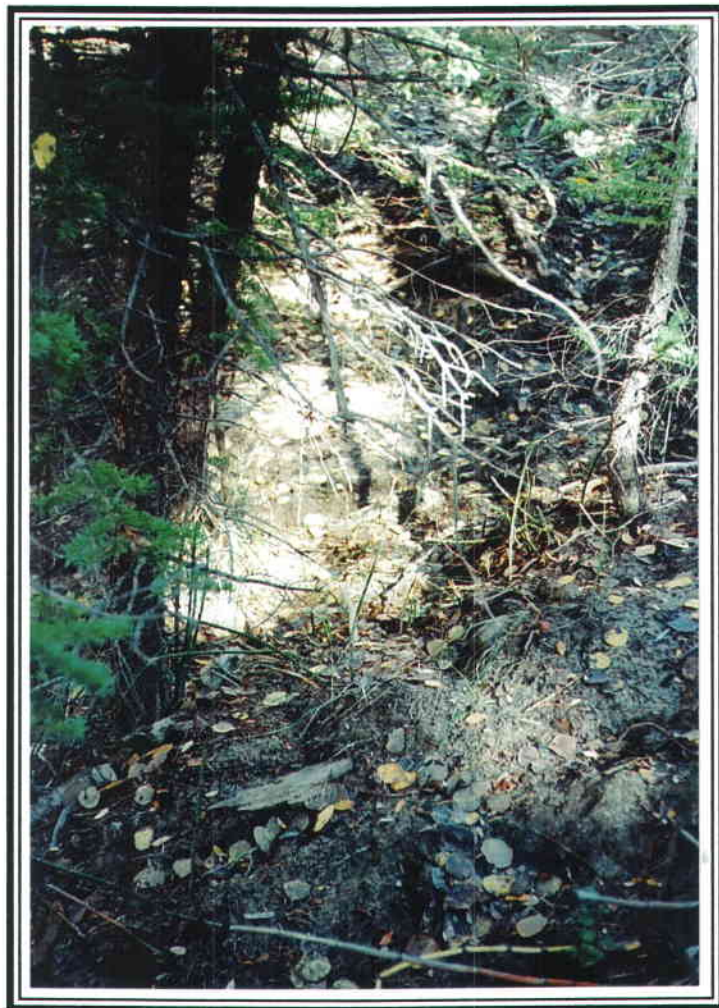
Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
EFB-S4*	EFB-14	Left	10.0	<i>Equisetum arvense</i>
		Right	0.0	<i>Equisetum arvense</i>
* (see notes above)		Channel	5.0	Bareground

EFB-S4: Cover by community types in Box Canyons (October 2008)

USDA Forest Service Protocol (1992)

	Cover (ft)
UPLAND VEGETATION	
<i>Populus tremuloides/Festuca ovina</i>	4.00
RIPARIAN VEGETATION	
<u>Dominant Woody Species</u>	
<u>Dominant Herbaceous Species</u>	
<i>Equisetum arvensis</i>	10.00
TOTAL COVER (Upland Species)	4.00
TOTAL COVER (Riparian Species)	10.00
BAREGROUND/LITTER	5.00
ROCK	0.00
WATER/MUD/DRY CHANNEL	0.00
MOSS	0.00
TOTAL COVER	19.00

PHOTOGRAPHIC DOCUMENTATION



EFB-S4 (EFB-14)

RIPARIAN COMPLEX DATA SHEET
October 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number RE-11

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: October 6-9, 2008

OBSERVER(S): P. Collins; S. Vlietstra

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: N

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: ~2°

ELEVATION: 8,265 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Wood's Rose/Aspen

Right: Aspen/Spruce

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: climax (but recent years' upper bank movement could influence status).

APPARENT FORAGE TREND: decreasing

ESTIMATED FORAGE PRODUCTION: 30 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Rosa woodsii</i>	<i>Equisetum arvense</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>			

POOL ATTRIBUTES

% area in pools: 50

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 80

% bank length gently sloping (>135°): 50 (above undercuts)

% bank length with overhanging vegetation: 30

BANK CONDITION

% bank length vegetated, stable: 10

% bank length unvegetated, stable: 20 (40% riparian cover on left; 0 on right; \bar{x} = 20%)

% bank length vegetated, unstable: 10

% bank length unvegetated, unstable: 40

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable):
unstable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) Sideslopes were noted as unstable in Fall 2003. The Spring 2004 sample period revealed that a large spruce tree had fallen directly on the sample area. The upland areas were unstable and movement of sample markers was observed. There were no riparian species in the transect area due to the fallen tree and extensive cattle disturbance in Spring and Fall 2004. Riparian species are returning here. In July 2005, right side had *Equisetum arvense* from hillside water. One sample period (October 2005) had some *Equisetum arvense* and *Agrostis stolonifera*. In October 2008, there was redbud on right side only.

2) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method. Green Line: Also measured on these transects.

3) During the flood of July 2006 vegetation was impacted. Also more erosional undercutting was observed. The upper left bank had more green vegetation that had moved downward (sloughing). Riparian spp. had low living cover.

4) Vegetation on left side - bareground on right side.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

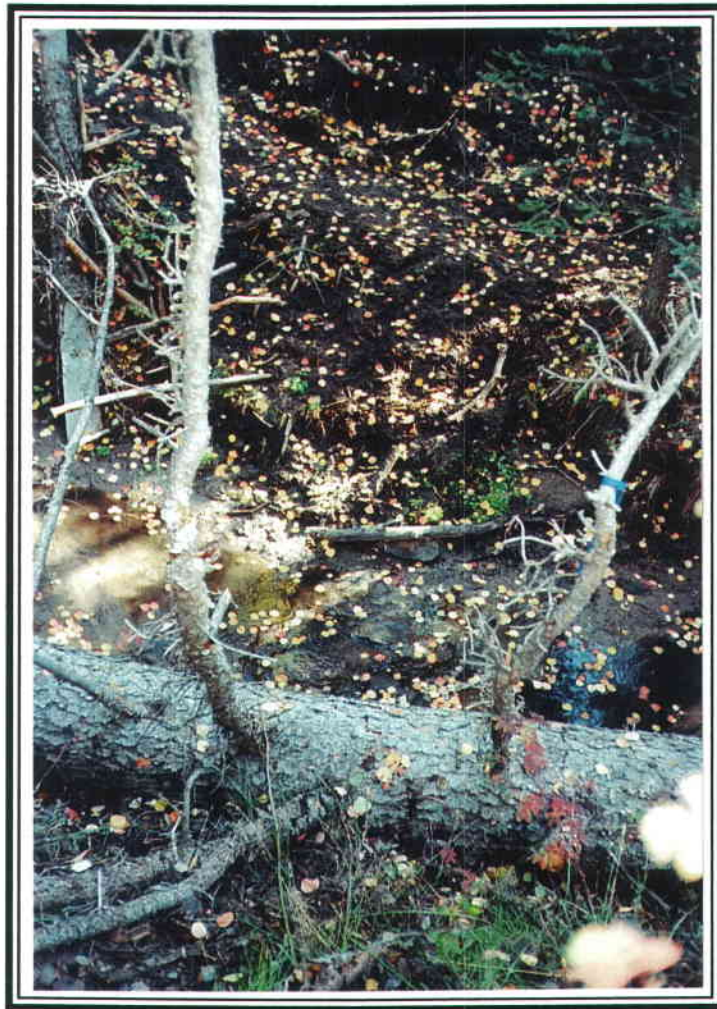
Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
RE-11		Left	2.0	<i>Agrostis stolonifera</i>
		Right	0.0	<i>Agrostis stolonifera</i>
		Channel	4.0 1.0 2.0	Water Rock B-G / Litter

RE-11: Cover by community types in Box Canyons (October 2008)

USDA Forest Service Protocol (1992)

	Cover (ft)
UPLAND VEGETATION	
<i>Populus tremuloides/Rosa woodsii</i>	20.00
RIPARIAN VEGETATION	
<u>Dominant Woody Species</u>	
<u>Dominant Herbaceous Species</u>	
<i>Agrostis stolonifera</i>	2.00
TOTAL COVER (Upland Species)	20.00
TOTAL COVER (Riparian Species)	2.00
BAREGROUND/LITTER	2.00
ROCK	1.00
WATER/MUD/DRY CHANNEL	4.00
MOSS	0.00
TOTAL COVER	29.00

PHOTOGRAPHIC DOCUMENTATION



RE-11

RIPARIAN COMPLEX DATA SHEET

October 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number RE-12

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: October 6-9, 2008

OBSERVER(S): P. Collins; S. Vlietstra

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: N

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 2^\circ$

ELEVATION: 8,275 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 107
- Family: Scout
- Composition:
 - Scout Family Soils: 35 %
 - Doney Family Soils: 25%
 - Guben Family Soils: 25%
 - Contrasting inclusions of rock outcrops, shallow soils, and more sandy or more clayey soils: 15%
 -

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Sagebrush/Grass

Right: Wood's Rose/Aspen

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: Seral

APPARENT FORAGE TREND: Unstable

ESTIMATED FORAGE PRODUCTION: 300 lbs./ac. (sign of animal grazing vegetation)

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Populus tremuloides</i>	<i>Salix sp.</i>	<i>Eriogonum sp.</i>	<i>Agrostis stolonifera</i>
<i>Salix sp.</i>	<i>Artemisia tridentata</i>	<i>Equisetum arvense</i>	<i>Juncus arcticus</i>
	<i>Rosa woodsii</i>		<i>Carex nebrascensis</i>
			<i>Poa secunda</i>

POOL ATTRIBUTES

% area in pools: 0 (no water present)

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 50

% bank length with overhanging vegetation: 5

BANK CONDITION

% bank length vegetated, stable: 45

% bank length unvegetated, stable: 30

% bank length vegetated, unstable: 5

% bank length unvegetated, unstable: 20

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

- 1) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method.
- 2) There was a large sandstone boulder (size of 2 automobiles) that rolled down into the creek bottom from the side-slopes.
- 3) Photo taken from left side.
- 4) No water was present.
- 5) Dry bottom but some vegetation was coming in from the bank (Nebraska sedge).

- 6) Heavy flooding was observed July 19-20, 2006. There were lots of sediments within the riparian species, often covering them. Live aspen on the side slopes just above the stream had toppled (photographs are on file).
- 7) There is usually water present at this site, but not this sample period.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
RE-12		Left	2.5	<i>Agrostis stolonifera</i>
		Right	3.5	<i>Agrostis stolonifera</i> / <i>Carex nebrascensis</i>
		Channel	0.0 2.0	Water Bareground

RE-12: Cover by community types in Box Canyons (October 2008)

USDA Forest Service Protocol (1992)

UPLAND VEGETATION

	Cover (ft)
<i>Artemisia tridentata</i> / <i>Elymus trachycaulus</i>	13.00
<i>Populus tremuloides</i> / <i>Rosa woodsii</i>	8.00

RIPARIAN VEGETATION

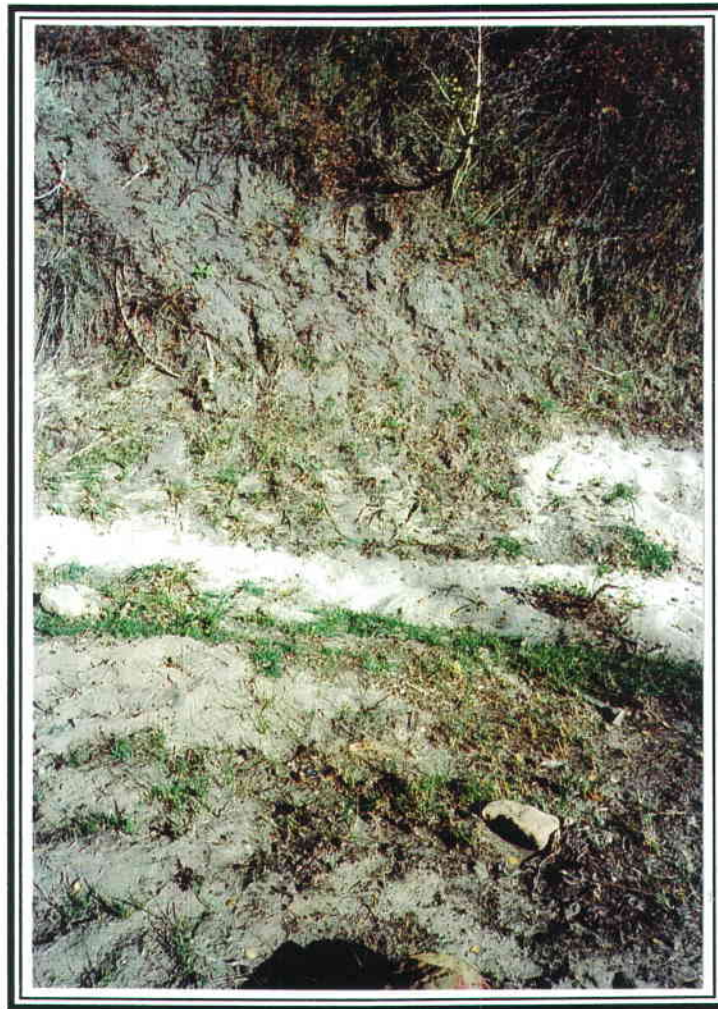
Dominant Woody Species

Dominant Herbaceous Species

<i>Agrostis stolonifera</i>	2.50
<i>Agrostis stolonifera</i> / <i>Carex nebrascensis</i>	3.50

TOTAL COVER (Upland Species)	21.00
TOTAL COVER (Riparian Species)	6.00
BAREGROUND/LITTER	2.00
ROCK	0.00
WATER/MUD/DRY CHANNEL	0.00
MOSS	0.00
TOTAL COVER	29.00

PHOTOGRAPHIC DOCUMENTATION



RE-12

RIPARIAN COMPLEX DATA SHEET

October 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number RE-13

WATERBODY NAME: East Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: October 6-9, 2008

OBSERVER(S): P. Collins; S. Vlietstra

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: NW

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 2^{\circ}$

ELEVATION: 8,315 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Aspen

Right: Aspen/Ponderosa Pine

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: Seral

APPARENT FORAGE TREND: decreasing

ESTIMATED FORAGE PRODUCTION: 35 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: *Yes*

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Artemisia tridentata</i>	<i>Ranunculus cymbalaria</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Potentilla fruticosa</i>	<i>Equisetum arvense</i>	<i>Carex lanuginosa</i>
<i>Pinus ponderosa</i>	<i>Symphoricarpos oreophilus</i>	<i>Artemisia dracunculus</i>	<i>Elymus trachycaulus</i>
		<i>Erigeron divergens.</i>	<i>Juncus sp.</i>
		<i>Achillea millefolium</i>	<i>Juncus arcticus</i>
		<i>Taraxacum officiale</i>	<i>Festuca ovina</i>
		<i>Potentilla sp.</i>	<i>Poa secunda</i>

POOL ATTRIBUTES

% area in pools: n/a (no water at this site)

% pool area made up of pools > 2' deep: n/a (no water at this site)

AQUATIC VEGETATION

% streambed with filamentous algae: n/a (no water at this site)

% stream margin with rooted aquatic: n/a (no water at this site)

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 0

% bank length with overhanging vegetation: 10

BANK CONDITION

% bank length vegetated, stable: 5

% bank length unvegetated, stable: 10

% bank length vegetated, unstable: 5

% bank length unvegetated, unstable: 80

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

- 1) There was lots of sand on banks and bottoms from the recent flooding.
- 2) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method.
- 3) Site was dry.
- 4) Dry, sandy bottom; unstable side slope and channel banks.

- 5) Lots of bank erosion from floods of upper drainage.
- 6) Riparian vegetation was lost to flooding.
- 7) Like mentioned in the July sample period, there seemed to be more sand on the channel bottom (likely do to flood events) above EFB-07. Additionally, it seemed like there was less riparian vegetation along the reaches, another possible consequence of flooding activities. Also, no water was observed above this sample station (unlike other sample periods).

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

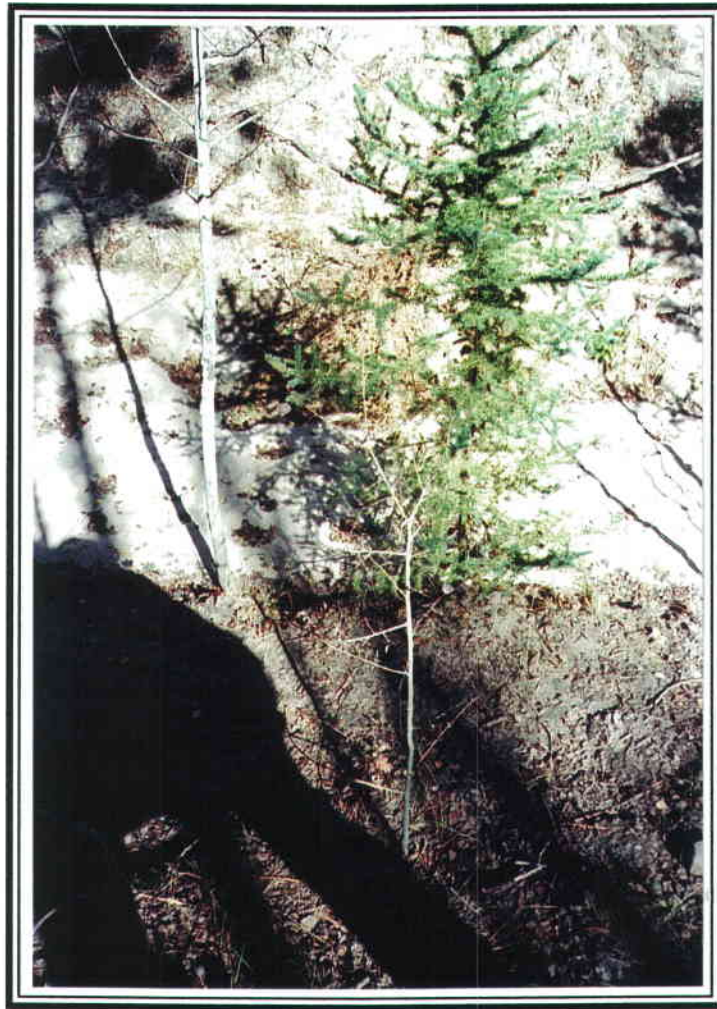
Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
RE-13		Left	2.5	<i>Agrostis stolonifera</i>
		Right	1.0	<i>Agrostis stolonifera</i>
		Channel	4.5	Bareground (sand)

RE-13: Cover by community types in Box Canyons (October 2008)

USDA Forest Service Protocol (1992)

	Cover (ft)
UPLAND VEGETATION	
<i>Artemisia tridentata/Elymus trachycaulus</i>	10.00
<i>Populus tremuloides</i>	9.00
RIPARIAN VEGETATION	
<u>Dominant Woody Species</u>	
<u>Dominant Herbaceous Species</u>	
<i>Agrostis stolonifera</i>	3.50
TOTAL COVER (Upland Species)	19.00
TOTAL COVER (Riparian Species)	3.50
BAREGROUND/LITTER	4.50
ROCK	0.00
WATER/MUD/DRY CHANNEL	0.00
MOSS	0.00
TOTAL COVER	27.00

PHOTOGRAPHIC DOCUMENTATION



RE-13

RIPARIAN COMPLEX DATA SHEET

October 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number R-07

WATERBODY NAME: Main Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: October 6-9, 2008

OBSERVER(S): P. Collins; S. Vlietstra

QUAD NAME: Emery West, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: NW

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 2^\circ$

ELEVATION: 8,220 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Spruce/Aspen

Right: Aspen/Spruce

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: climax (but recent years' upper bank movement could influence status).

APPARENT FORAGE TREND: stable

ESTIMATED FORAGE PRODUCTION: 50 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: *Yes*

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: *Mining, grazing, hunting, recreation.*

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Juniperus communis</i>	<i>Achillea millefolium</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Potentilla fruticosa</i>	<i>Equisetum arvense</i>	<i>Carex lanuginosa</i>
<i>Betula occidentalis</i>		<i>Antennaria sp.</i>	
		<i>Artemisia ludoviciana</i>	
		<i>Geranium richardsonii</i>	

POOL ATTRIBUTES

% area in pools: *n/a (no water at this site)*

% pool area made up of pools > 2' deep: *n/a (no water at this site)*

AQUATIC VEGETATION

% streambed with filamentous algae: *n/a (no water at this site)*

% stream margin with rooted aquatic: *n/a (no water at this site)*

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): *30*

% bank length gently sloping (>135°): *35*

% bank length with overhanging vegetation: *35*

BANK CONDITION

% bank length vegetated, stable: *25*

% bank length unvegetated, stable: *35*

% bank length vegetated, unstable: *5*

% bank length unvegetated, unstable: *35*

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): *stable (left side); unstable (right side)*

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) Photo taken from the left side

2) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method.

- 3) Part of riparian spp. are in the channel (2 ft).
- 4) No water at site.
- 5) Large rock/boulder in middle middle of channel has always made it difficult to measure consistently. The tape was usually placed up and over the rock.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
R-07		Left	1.0	<i>Agrostis stolonifera</i> / <i>Carex lanuginosa</i>
		Right	0.0	<i>Agrostis stolonifera</i> / <i>Carex lanuginosa</i>
		Middle	2.0	<i>Carex lanuginosa</i>
		Channel	12.0 2.0	Bareground Rock

R-07: Cover by community types in Box Canyons (October 2008)

USDA Forest Service Protocol (1992)

	Cover (ft)
UPLAND VEGETATION	
<i>Picea pungens</i>	10.00
<i>Populus tremuloides</i>	10.50
RIPARIAN VEGETATION	
<u>Dominant Woody Species</u>	
<u>Dominant Herbaceous Species</u>	
<i>Carex lanuginosa</i> / <i>Agrostis stolonifera</i>	3.00
TOTAL COVER (Upland Species)	20.50
TOTAL COVER (Riparian Species)	3.00
BAREGROUND/LITTER	12.00
ROCK	2.00
WATER/MUD/DRY CHANNEL	0.00
MOSS	0.00
TOTAL COVER	37.50

PHOTOGRAPHIC DOCUMENTATION



R-07

RIPARIAN COMPLEX DATA SHEET

October 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number R-09

WATERBODY NAME: Main Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: October 6-9, 2008

OBSERVER(S): P. Collins; S. Vlietstra

QUAD NAME: Emery West, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: N

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 2^{\circ}$

ELEVATION: 8,210 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Spruce/Aspen

Right: Aspen/Horsetail

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: climax (but recent years' upper bank movement could influence status).

APPARENT FORAGE TREND: stable

ESTIMATED FORAGE PRODUCTION: 500 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Salix lutea</i>	<i>Ranunculus cymbalaria</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Artemisia tridentata</i>	<i>Equisetum arvense</i>	<i>Juncus longistylis</i>
<i>Juniperus scopulorum</i>	<i>Rosa woodsii</i>		<i>Juncus arcticus</i>
			<i>Carex lanuginosa</i>

POOL ATTRIBUTES

% area in pools: 0 (dry)

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 50

% bank length gently sloping (>135°): 40

% bank length with overhanging vegetation: 50

BANK CONDITION

% bank length vegetated, stable: 85

% bank length unvegetated, stable: 10

% bank length vegetated, unstable: 0

% bank length unvegetated, unstable: 5

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable (left side); moderately stable (right side)

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

- 1) Photo taken from the left side.
- 2) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method.
- 3) The left side of the river there were mostly riparian species. It was difficult to tell if it was from hillside water or stream. Seemed more like stream influence.
- 4) The right side had hillside water influence.

- 5) No water at site, but the channel was completely vegetated.
6) Stream channel between R-07 and R-09 had no running water. Water began about 15 ft downstream from R-09.

DATA SUMMARIES

GREEN LINE WIDTH (HYDRIC) & COMMUNITY TYPE :

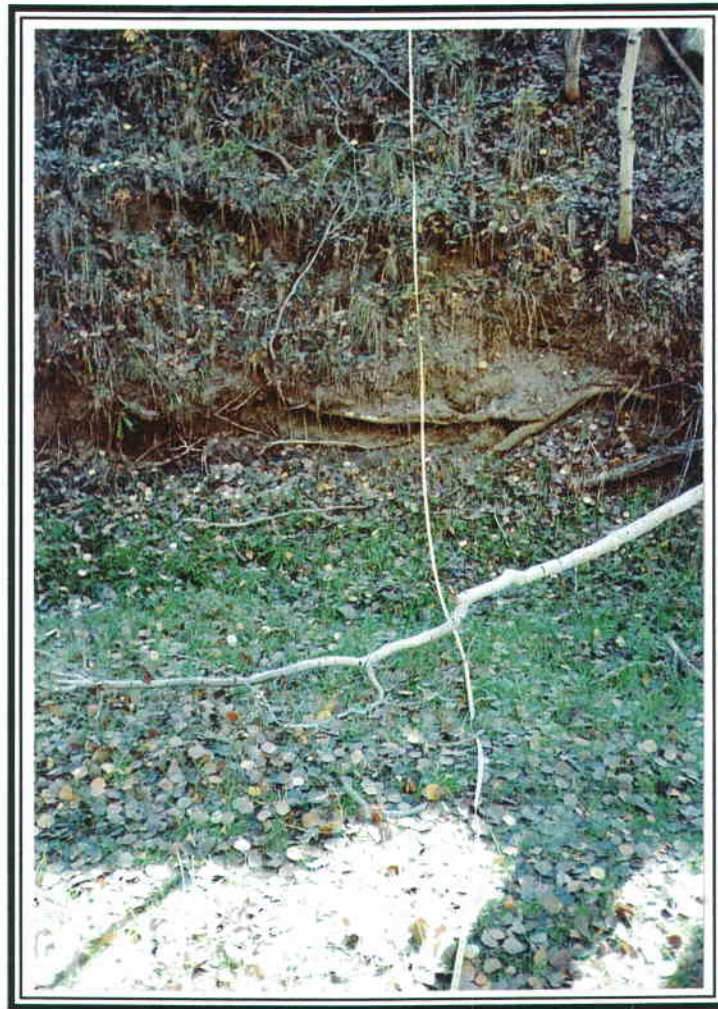
Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
R-09		Left	7.0	<i>Equisetum arvense</i> / <i>Agrostis stolonifera</i> / <i>Carex lanuginosa</i>
		Right	3.0	<i>Equisetum arvense</i>
		Channel	0.0	Dry

R-09: Cover by community types in Box Canyons (October 2008)

USDA Forest Service Protocol (1992)

	Cover (ft)
UPLAND VEGETATION	
<i>Populus tremuloides</i>	19.00
RIPARIAN VEGETATION	
<u>Dominant Woody Species</u>	
<u>Dominant Herbaceous Species</u>	
<i>Carex lanuginosa</i>	10.00
TOTAL COVER (Upland Species)	19.00
TOTAL COVER (Riparian Species)	10.00
BAREGROUND/LITTER	0.00
ROCK	0.00
WATER/MUD/DRY CHANNEL	0.00
MOSS	0.00
TOTAL COVER	29.00

PHOTOGRAPHIC DOCUMENTATION



R-09

RIPARIAN COMPLEX DATA SHEET
October 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number R-11

WATERBODY NAME: Main Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: October 6-9, 2008

OBSERVER(S): P. Collins; S. Vlietstra

QUAD NAME: Emery West, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: NNW

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: ~2°

ELEVATION: 8,180 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Spruce/Grass

Right: Aspen/Wood's Rose

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: climax (but recent years' upper bank movement could influence status).

APPARENT FORAGE TREND: stable

ESTIMATED FORAGE PRODUCTION: 350 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Rosa woodsii</i>	<i>Epilobium angustifolium</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>		<i>Equisetum arvense</i>	<i>Juncus longistylis</i>
<i>Salix sp.</i>		<i>Ranunculus cymbalaria</i>	<i>Juncus arcticus</i>
			<i>Poa secunda</i>

POOL ATTRIBUTES

% area in pools: 100

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 40

% bank length gently sloping (>135°): 60

% bank length with overhanging vegetation: 10

BANK CONDITION

% bank length vegetated, stable: 35

% bank length unvegetated, stable: 20

% bank length vegetated, unstable: 0

% bank length unvegetated, unstable: 45

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable):
moderately stable (left side); stable (right side)

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

- 1) Photograph taken from the left side.
- 2) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method.
- 3) Right stake was missing. For transect, we measured from aspen tree (see photo) with blue flag.
- 4) Left side ave. 70% veg [ave. of two sides therefore 35% (see Bank Condition above)].
- 5) Left side had more riparian vegetation and less upland.
- 6) Stream channel between R-09 and R-11 had some water this sample period. There were a couple of rock side pools.
- 7) Unlike July '08, sample area channel was water present.

8) Channel width was 5 ft (wider than previous sample periods). Channel was sandy and wet; some plant establishing in channel now.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
R-11		Left	8.0	<i>Agrostis stolonifera/Juncus longistylis</i>
		Right	0.0	<i>Equisetum arvense/Juncus longistylis</i>
		Channel	2.0/2.0	Bareground/water

R-11: Cover by community types in Box Canyons (October 2008)

USDA Forest Service Protocol (1992)

Cover (ft)

UPLAND VEGETATION

Picea pungens/Rosa woodsii

15.00

RIPARIAN VEGETATION

Dominant Woody Species

Dominant Herbaceous Species

Equisetum arvense

4.00

Juncus longistylis/Agrostis stolonifera

4.00

TOTAL COVER (Upland Species)

15.00

TOTAL COVER (Riparian Species)

8.00

BAREGROUND/LITTER

2.00

ROCK

0.00

WATER/MUD/DRY CHANNEL

2.00

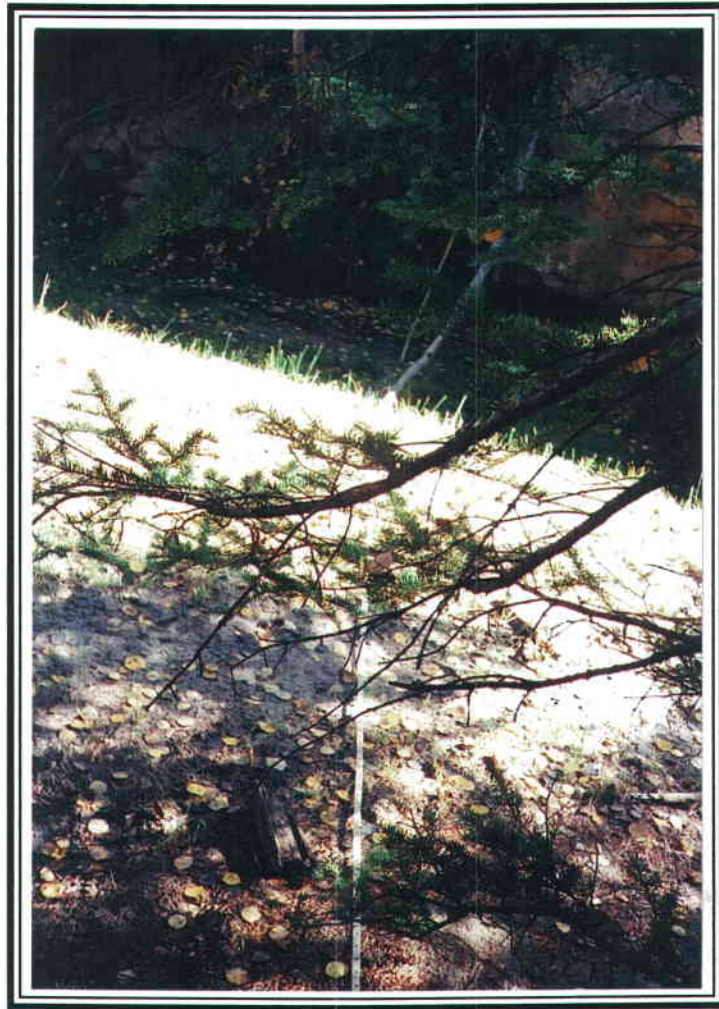
MOSS

0.00

TOTAL COVER

27.00

PHOTOGRAPHIC DOCUMENTATION



R-11

RIPARIAN COMPLEX DATA SHEET

October 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number R-13

WATERBODY NAME: Main Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: October 6-9, 2008

OBSERVER(S): P. Collins; S. Vlietstra

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss

ASPECT: NNW

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 2^\circ$

ELEVATION: 8,175 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Spruce

Right: Spruce/Aspen

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: climax (but recent years' upper bank movement could influence status).

APPARENT FORAGE TREND: stable

ESTIMATED FORAGE PRODUCTION: 200 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Potentilla fruticosa</i>	<i>Equisetum arvense</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Juniperus communis</i>	<i>Cirsium</i> sp.	<i>Carex nebrascensis</i>
<i>Salix lucida</i>		<i>Ranunculus cymbalaria</i>	<i>Carex lanuginosa</i>
<i>Salix</i> sp.			<i>Juncus longistylis</i>
			<i>Bromus carinatus</i>
			<i>Elymus trachycaulus</i>
			<i>Juncus arcticus</i>
			<i>Poa fendleriana</i>

POOL ATTRIBUTES

% area in pools: (dry)

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 0

% bank length gently sloping (>135°): 40

% bank length with overhanging vegetation: 50

BANK CONDITION

% bank length vegetated, stable: 20

% bank length unvegetated, stable: 35

% bank length vegetated, unstable: 20

% bank length unvegetated, unstable: 25

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) There was a discrepancy with total transect length between 1999 (42 ft.) and Oct 2003 (45 ft.); July 2004, October 2004, July 2005, October 2005, July 2006 were consistent at 45 ft, October 2007 (46 ft), July 2008 (46 ft), October 2008 (46 ft).

2) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method. Green Line: Also measured on these transects.

- 3) Photograph taken from the left side.
- 4) The site was very different this sample period. I called most of the vegetation as 'riparian', but that was questionable because much of the cover of riparian species was quite sparse.
- 5) There was some water in the channel between R-11 and R-13.
- 6) A lot of sandy substrate was deposited at this site from the side channel.
- 7) A large storm event brought a lot of sandy to channel. Much riparian vegetation my be lost from this event.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
R-13		Left	3.0	<i>Carex lanuginosa</i>
		Right	3.0	<i>Juncus arcticus</i>
		Channel	6	Bareground

R-13: Cover by community types in Box Canyons (October 2008)

USDA Forest Service Protocol (1992)

Cover (ft)

UPLAND VEGETATION

Picea pungens 34.00

RIPARIAN VEGETATION

Dominant Woody Species

Dominant Herbaceous Species

Carex lanuginosa 3.00

Juncus arcticus 3.00

TOTAL COVER (Upland Species) 34.00

TOTAL COVER (Riparian Species) 6.00

BAREGROUND/LITTER 0.00

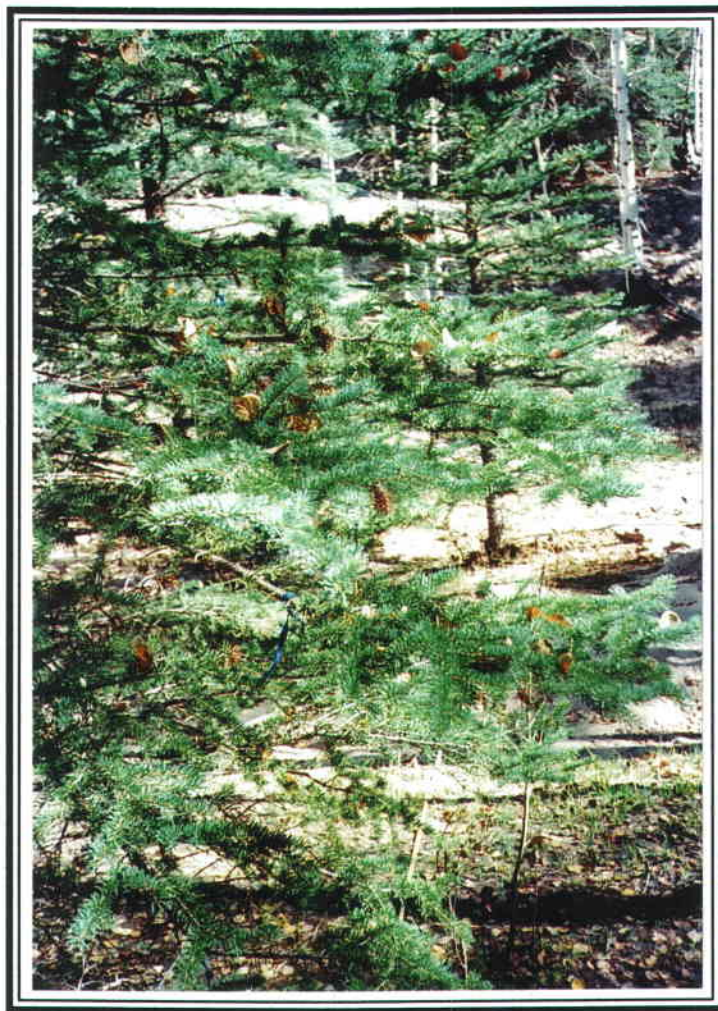
ROCK 0.00

WATER/MUD/DRY CHANNEL 6.00

MOSS 0.00

TOTAL COVER 46.00

PHOTOGRAPHIC DOCUMENTATION



R-13

RIPARIAN COMPLEX DATA SHEET
October 2008

CLIENT: Canyon Fuel Company

COMPLEX: Riverine - Number R-15

WATERBODY NAME: Main Fork Box Canyon

LOCATION: Southern Wasatch Plateau, Utah

DATE: October 6-9, 2008

OBSERVER(S): P. Collins; S. Vlietstra

QUAD NAME: Flagstaff Peak, Utah

GEOLOGIC PARENT MATERIAL: Castlegate Ss (Blackhawk Fm just upstream)

ASPECT: N

VALLEY BOTTOM TYPE: II

STREAM GRADIENT: $\sim 2^{\circ}$

ELEVATION: 8,170 ft.

SIZE OF COMPLEX: (see quantitative data)

SOILS INFORMATION: (USDA Forest Service. 1997 (Unpub.). Manti La Sal National Forest. Manti Division. Price, UT.)

- Soil Map Unit No. 57
- Family: Falcon
- Composition:
 - Falcon Family Soils: 55 %
 - Sandstone Outcrop: 30%
 - Contrasting inclusions of deeper, more stony, and sandier soils: 15%

ADJACENT UPLAND VEGETATION (looking downstream)

Left: Spruce/Aspen

Right: Spruce

VEGETATIVE DESCRIPTION (Dominance by Community Types)

Community Name	% of Complex
(refer to quantitative data summaries for this information)	

SUCCESSIONAL STATUS: active movement (not climax)

APPARENT FORAGE TREND: moderately stable

ESTIMATED FORAGE PRODUCTION: 100 lbs./ac.

BEAVER ACTIVITY: none observed

PHOTOGRAPH TAKEN: Yes

LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA: Mining, grazing, hunting, recreation.

SPECIES OBSERVED:

Trees	Shrubs	Forbs	Grasses (or grasslike)
<i>Picea pungens</i>	<i>Juniperus communis</i>	<i>Aster sp.</i>	<i>Agrostis stolonifera</i>
<i>Populus tremuloides</i>	<i>Symphoricarpos oreophilus</i>	<i>Equisetum arvense</i>	
<i>Cornus stolonifera</i>	<i>Salix lutea</i>	<i>Epilobium angustifolium</i>	
	<i>Rosa woodsii</i>		

POOL ATTRIBUTES

% area in pools: 70

% pool area made up of pools > 2' deep: 0

AQUATIC VEGETATION

% streambed with filamentous algae: 0

% stream margin with rooted aquatic: 0

BANK TYPE & VEGETATION OVERHANG

% bank length undercut (<90°): 20

% bank length gently sloping (>135°): 20

% bank length with overhanging vegetation: 20

BANK CONDITION

% bank length vegetated, stable: 20

% bank length unvegetated, stable: 60

% bank length vegetated, unstable: 0

% bank length unvegetated, unstable: 20

BANK STABILITY (bankfull area only; many sideslopes above these areas were quite unstable): stable (left side); unstable (right side)

CHANNEL MORPHOLOGY

(Cross-sections, stream profiles and other geomorphological data for the East Fork of Box Canyon was measured by another team of scientists).

NOTES:

1) Left side had horsetail in the "upland" area, but it was high enough in elevation that we felt it was influenced by side-slope water.

2) Quantitative Methods: Used USDA Forest Service Protocol for Level III by measuring the plant communities using the line intercept method. Green Line: Also measured on these transects.

3) Length of transect line in Oct. 2003 was less than 1999 due to movement; since that time it has been fairly consistent (25.5 ft July 2008; 25.0 ft October 2008).

5) There was no riparian vegetation on the transect line in July '08, but in October '08 there was 3 ft of horsetail.

6) The bottomline in the Main Fork between R-07 and R-15 is that there was much more sand deposited in channel bottom. Also the channel appeared wider with less water and less living cover in the riparian zone.

DATA SUMMARIES

GREEN LINE WIDTH (HYDROPHYTIC) & COMMUNITY TYPE :

Sample Site	Other Name	Side of Stream (looking downstream)	Width (ft.)	Community Type
R-15		Left	3.0	<i>Agrostis stolonifera</i>
		Right	0.0	
		Channel	1.5	Water
			5.5	Bareground/Litter

R-15: Cover by community types in Box Canyons (October 2008)

USDA Forest Service Protocol (1992)

Cover (ft)

UPLAND VEGETATION

Populus tremuloides/Picea pungens

15.00

RIPARIAN VEGETATION

Dominant Woody Species

Dominant Herbaceous Species

Equisetum arvensis

3.00

TOTAL COVER (Upland Species) 15.00

TOTAL COVER (Riparian Species) 3.00

BAREGROUND/LITTER 5.50

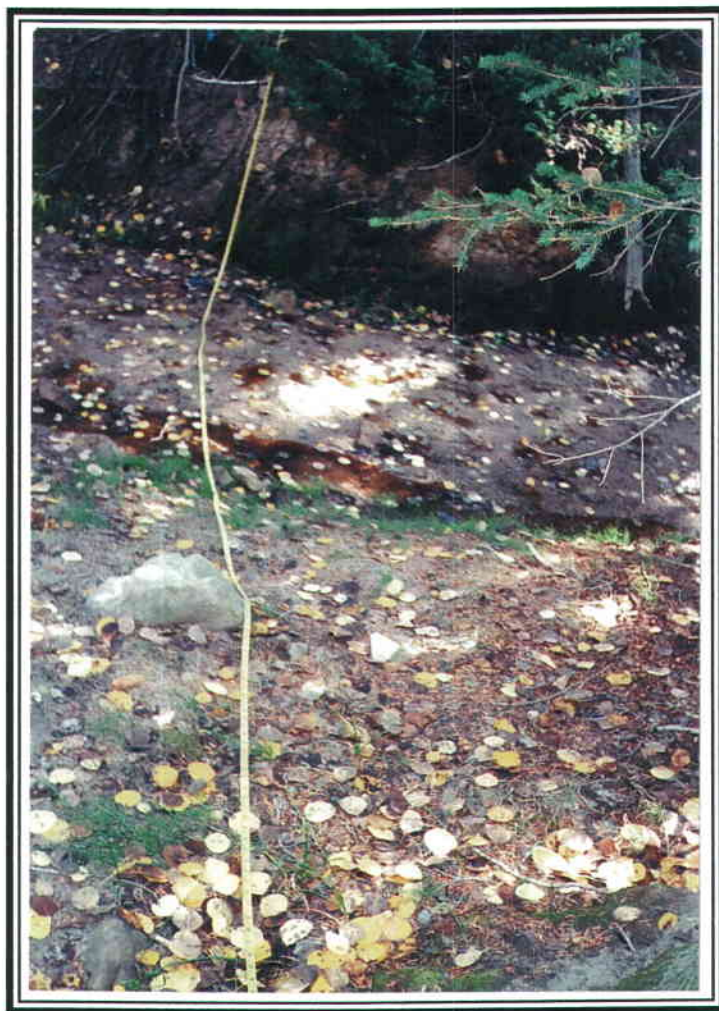
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WATER/MUD/DRY CHANNEL 1.50

MOSS 0.00

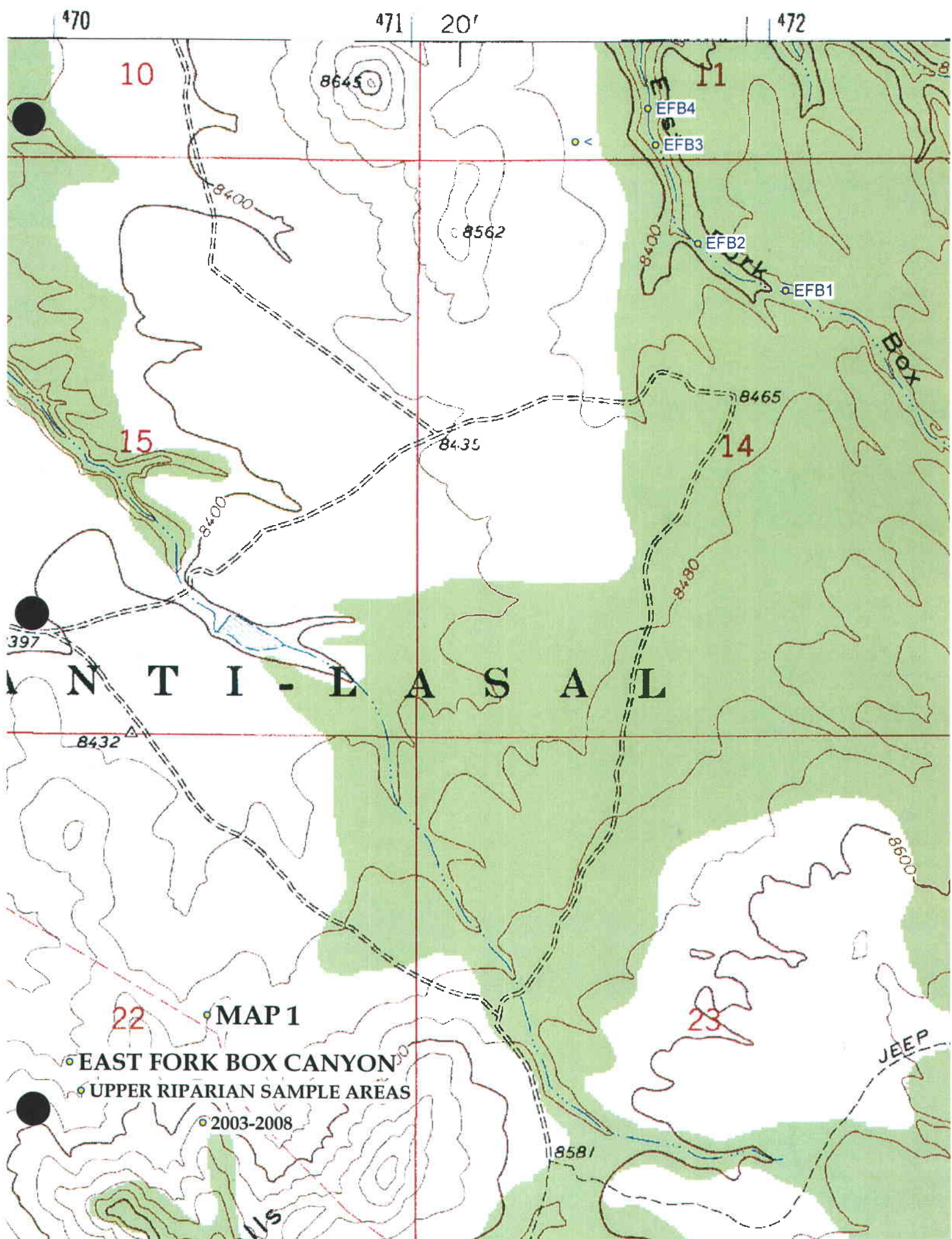
TOTAL COVER 25.00

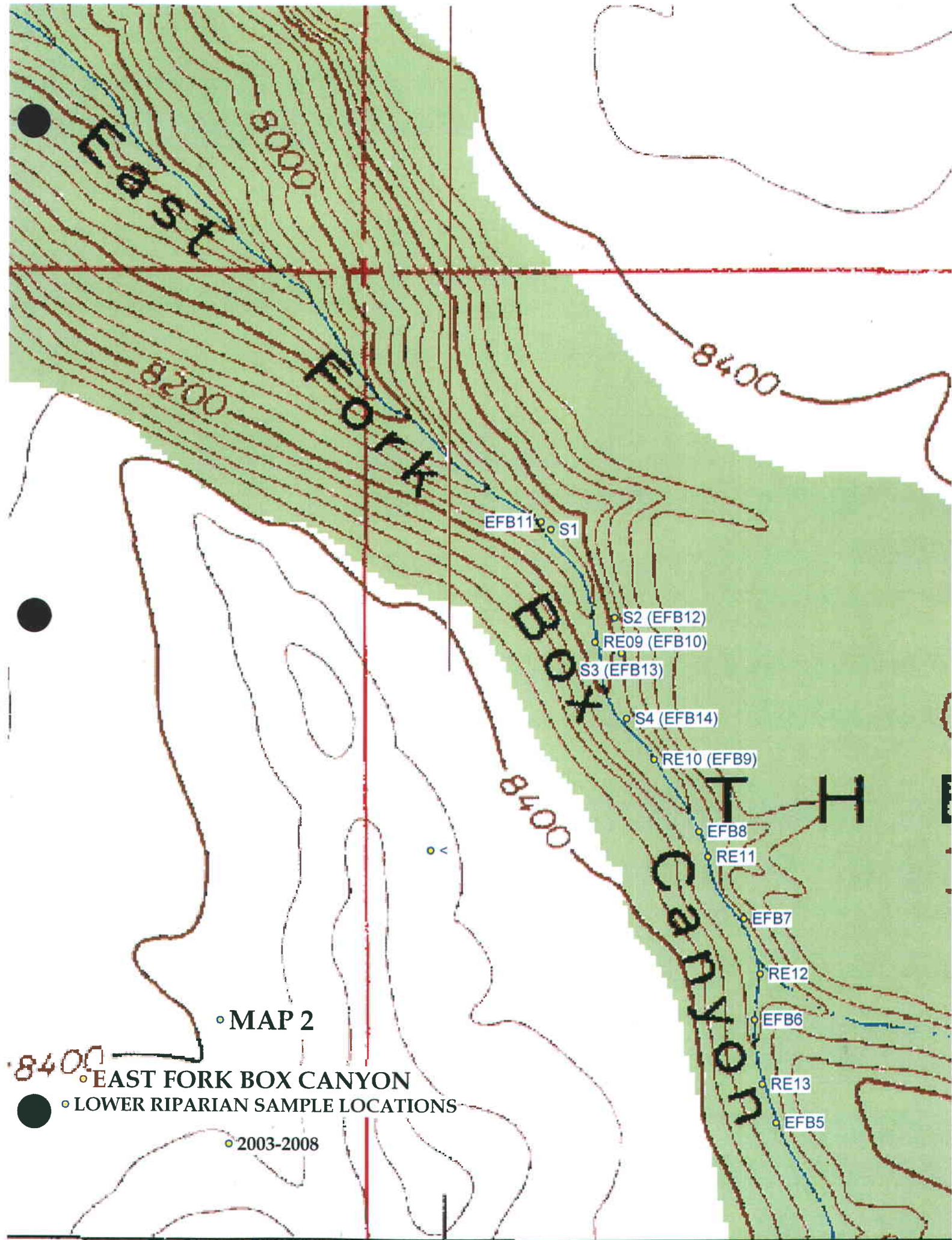
PHOTOGRAPHIC DOCUMENTATION



R-15

SAMPLE AREA MAPS





469

MAYFIELD 36 MI.

R13

R11

R9

R7

8356

8400

16

Canyon

MAP 3

MAIN FORK BOX CANYON

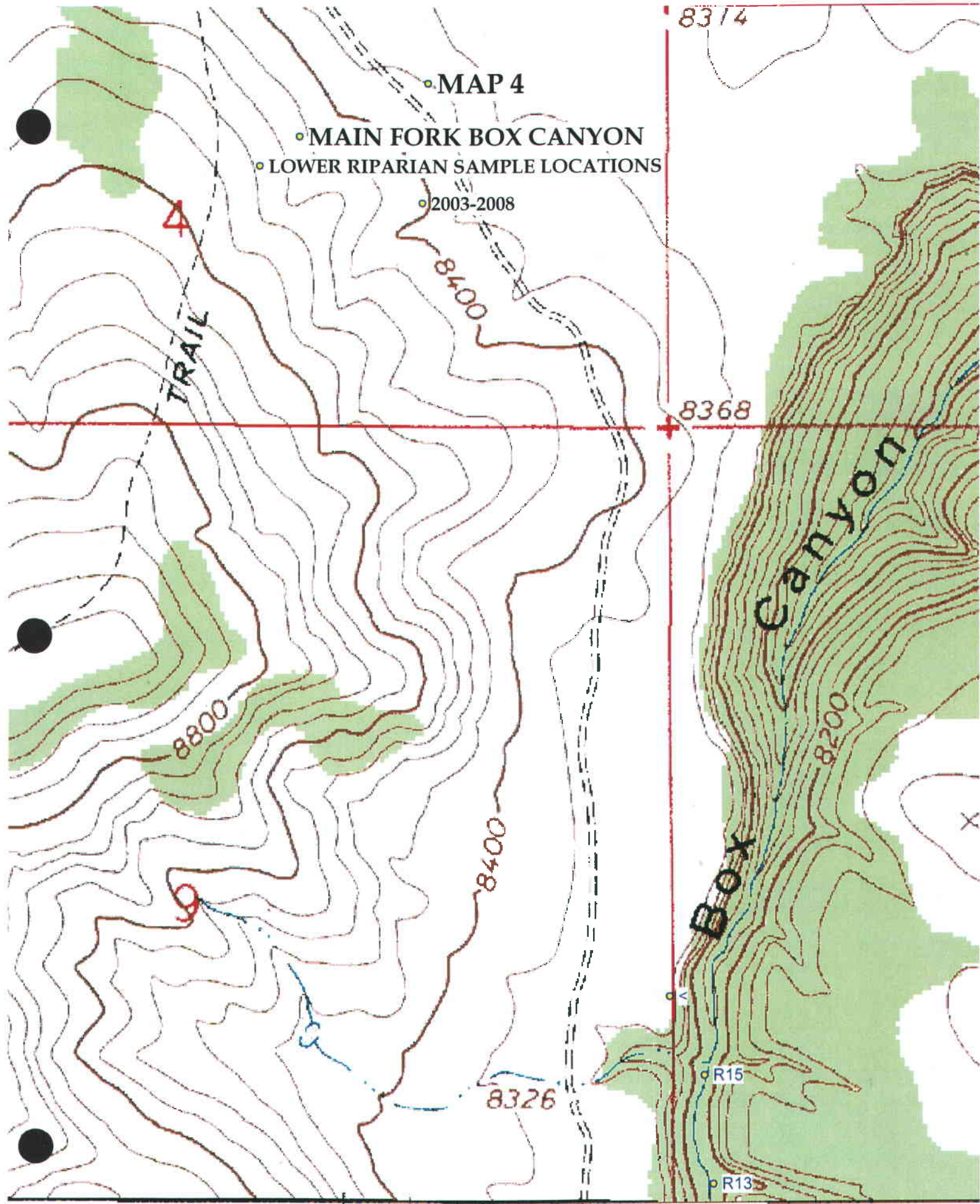
UPPER RIPARIAN SAMPLE LOCATIONS

2003-2008

835

M

A



MAP 4

MAIN FORK BOX CANYON

LOWER RIPARIAN SAMPLE LOCATIONS

2003-2008

8374

8368

4

TRAIL

8800

8400

8400

Canyon

8200

8326

Box

R15

R13

2 040 000 FEET

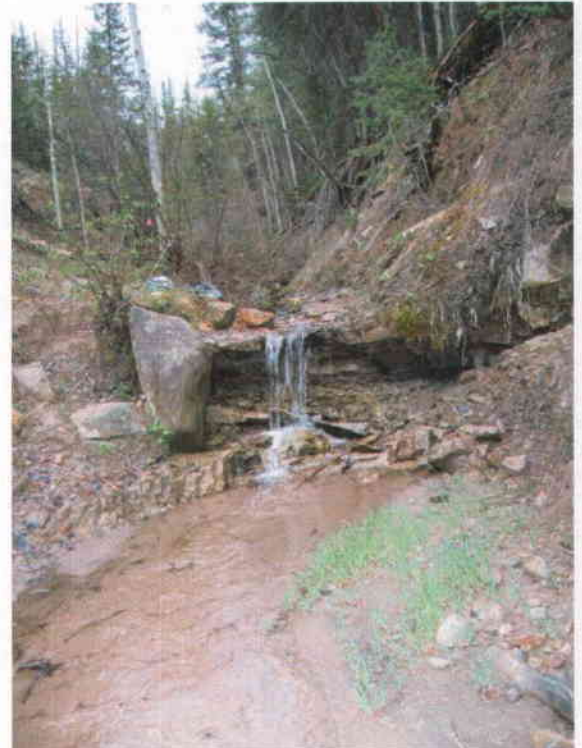
469

EMERY 2 MI.

**Final Report of Hydrologic
Monitoring of the East Fork of
Box Canyon Creek,
2003-2008, Sufco Mine**

8 May 2009

Canyon Fuel Company, LLC
Sufco Mine
Salina, Utah



PETERSEN HYDROLOGIC, LLC
CONSULTANTS IN HYDROGEOLOGY

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Monitoring of the East Fork of
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8 May 2009

Canyon Fuel Company, LLC
SUFCO Mine
Salina, Utah

Prepared by:

A handwritten signature in black ink, appearing to read 'EAP', is written over a circular professional seal. The seal is light gray and contains the text 'ERIK C. PETERSEN' and 'UTAH P.G. NO. 5373615-2250' around the perimeter.

Erik C. Petersen, P.G.
Senior Hydrogeologist
Utah P.G. No. 5373615-2250



PETERSEN HYDROLOGIC, LLC
CONSULTANTS IN HYDROGEOLOGY

2695 N. 600 E.
LEHI, UTAH 84043
(801) 766-4006

**Final Report of Hydrologic Monitoring of the
East Fork of Box Canyon Creek, 2003-2008**

1.0 Introduction

The Canyon Fuel Company, LLC (CFC) Sufco Mine is located in the southern Wasatch Plateau coal district, approximately 20 miles east of Salina, Utah. During late 2003, longwall mining in the 3 Left Pines East (3LPE) longwall panel commenced beneath a portion of the East Fork of Box Canyon Creek, a tributary to Box Canyon Creek (Figure 1). Beginning in mid-November 2003 and continuing through early January 2004, an approximately 2,000-foot reach of the East Fork stream drainage was undermined and subsided. During 2005, longwall mining in the 4LPE and 5LPE panels occurred beneath the upper reaches of the East Fork of Box Canyon drainage (Figure 1). During 2006 mining occurred in the 6LPE longwall panel, which is the easternmost Pines longwall mining panel (Figure 1). No longwall mining in the East Fork Drainage occurred during 2007 or 2008.

In accordance with Sufco's approved mining plan for the undermining of the East Fork, CFC committed to performing routine monitoring of discharge rates in potentially impacted stream reaches and springs. CFC commissioned Petersen Hydrologic, LLC to perform this monitoring, commencing in October 2003. The complete results of the monitoring activities at the East Fork of Box Canyon through 2008 are summarized in this report.

Reports summarizing the yearly results of monitoring activities in the East Fork of Box Canyon Creek have previously been submitted to the Division of Oil, Gas and Mining. This is the final report of monitoring activities in the East Fork of Box Canyon. This report summarizes the results of the East Fork monitoring activities in their entirety from 2003 to 2008.

Including this introduction, this report contains the following sections:

1. Introduction
2. Methods of Study
3. Presentation of Data
4. Overview of Hydrology of the East Fork
5. Discussion
6. References Cited

2.0 Methods of Study

- A site visit to the East Fork of Box Canyon was made on 22-23 September 2003 with representatives of the Utah Division of Oil, Gas, and Mining, the Manti La Sal National Forest, and CFC. During this site visit, locations along the East Fork of Box Canyon Creek and at adjacent springs were selected for flow monitoring. The designated monitoring sites were labeled and marked in the field with flagging and wooden stakes. At a later time, additional monitoring sites in the East Fork drainage were selected for periodic monitoring.

Additional monitoring data in the East Fork drainage were collected as part of CFC's regular quarterly hydrologic monitoring program during 2008 (DOGM, 2009; Petersen Hydrologic, 2007a, Petersen Hydrologic, 2007b).

- During the period of monitoring (2003-2008) the East Fork of Box Canyon was accessed and individual monitoring sites were monitored at intervals specified in the approved monitoring plan. During the summer and early fall months, the canyon was accessed by vehicle. Where possible, during the late fall, winter, and spring months, the canyon was accessed using ATV's or snowmobiles. During certain times of the year, the canyon could not reasonably be accessed in a safe manner.

- Discharge rates in the East Fork of Box Canyon Creek and at springs were measured using a stopwatch and a calibrated container. The measurements were performed by diverting the stream or spring discharge through a plastic pipe and performing time-to-fill measurements using a suitable container. Time-to-fill measurements were repeated at a site until the discharge through the pipe had stabilized. Generally, after the discharge from the pipe had stabilized, at least three additional time-to-fill measurements were performed. The time-to-fill values measured after the discharge had stabilized were averaged and used to calculate the discharge rate. Where noted, in a few instances, such as where stream flow was partially obscured beneath ice, discharge rates in the East Fork were estimated. Discharge at Pines 408 was measured using a 3-inch Parshall flume or a stopwatch and a calibrated container as appropriate.
- The monitoring stations were digitally photographed during monitoring events.
- The discharge data were compiled into electronic format and analyzed using graphical methods.

3.0 Presentation of Data

The locations of spring and stream monitoring stations in the East Fork drainage are shown on Figure 1. Also shown on Figure 1 are the locations of the 3, 4, 5, and 6 Left Pines East longwall panels in the East Fork area. Discharge measurements for the East Fork of Box Canyon Creek and nearby springs for the period 2003 - 2008 are presented in Table 1.

4.0 Overview of Hydrology of the East Fork of Box Canyon Drainage

The East Fork of Box Canyon is a small drainage that is tributary to Box Canyon Creek (Figure 1). Box Canyon Creek is tributary to Muddy Creek about 2 miles below the study area. Historically, discharge in the East Fork of Box Canyon Creek during the summer and fall months has ranged from about 8 to 22 gpm at the confluence with Box Canyon Creek (Utah Division of Oil, Gas and Mining, 2009, on-line hydrology database). During periods of drought, lower flows were sometimes measured. Appreciably higher flows are common during the spring runoff season and during heavy precipitation events.

Historically, the upper extent of perennial discharge in the East Fork of Box Canyon Creek has typically occurred near monitoring site EFB-6 (Sufco quarterly monitoring site Pines 106). Historically, above station EFB-6, the drainage has usually been mostly dry with meager flows (<1 gpm; Table 1) or zones of channel dampness sometimes present in a few short, isolated locations. Below EFB-6, the discharge in the creek gradually increases downstream as a result of discharge from shallow groundwater systems. During 2008, discharge in the creek was minimal between monitoring stations EFB-6 and EFB-7. A

discharge of about 0.1 gpm was observed during June 2008 a short distance below EFB-6. No flow was monitored between EFB-6 and EFB-7 during the later half of 2008. It should be noted that considerable deposits of sand were emplaced in the channel bottom in this reach of the stream during recent torrential precipitation events, which may have obscured more wetness in the channel underlying the sand. Perennial flow during 2008 started at monitoring site EFB-7. Based on observations of the stream channel made since 1998, it is apparent that the stream does not gain appreciably below monitoring station EFB-11. Rather, it has been observed that surface-water discharge rates in the middle and lower reaches of the East Fork of Box Canyon (below subsided areas) are sometimes lower than those near EFB-11 located higher in the drainage. This is particularly true in the hot summer and early fall months. This condition is likely a result of evapotranspiration losses and groundwater-surface water interactions between the creek and adjacent alluvial sediments in the middle and lower reaches of the canyon. The effects of evapotranspiration in the creek in the reach between EFB-11 and Pines 408 were readily apparent during the warm summer months of 2008.

During 2008, the flow in the East Fork was continuous from monitoring site EFB-7 to site EFB-11B (the lowermost stream monitoring site). The discharge in the creek below EFB-11B to the confluence with the main fork of Box Canyon Creek also appeared continuous when the area when the lower canyon area was traversed during 2008.

It is noteworthy that climatic conditions in the region have varied substantially during the period of monitoring at the East Fork of Box Canyon (2003-2008). This is illustrated in a

plot of the Palmer Hydrologic Drought Index (PHDI) for Utah Region 4 (Figure 2). The PHDI is a monthly numerical value generated by the National Climatic Data Center (NCDC) that indicates the severity of wet and dry spells. The PHDI is calculated from various hydrologic parameters including precipitation, temperature, evapotranspiration, soil water recharge, soil water loss, and runoff. Consequently, it is useful for evaluating the relationship between climatic conditions and groundwater discharge and potentiometric data. It is apparent in Figure 2 that the region was experiencing a mild to moderate drought during late 2003 and the first three quarters of 2004. Beginning in October of 2004 the region began a gradual transition into wetter climatic conditions. During 2005, the region experienced a continuous period of extreme wetness (Figure 2). During late 2005 the region began a gradual transition to the mild to moderate wetness conditions that persisted throughout 2006. Beginning in early 2007, the region transitioned to a period of drought that persisted through the end of the year (Figure 2). During early 2008, Utah Region 4 experienced a period of mild wetness and then transitioned back to a period of mild drought during the second half of 2008.

Additional site specific climatic data for the Sufco Permit area are available from the Salina 24E weather station, a National Weather Service weather station maintained near the Sufco Mine surface facilities. Precipitation data collected at the Salina 24E station for the period of record (1984-2008) are plotted as percent of normal in Figure 3. Plots of precipitation departures from normal at the Salina 24E station for the years 2003-2008 are presented in Figure 4. It is apparent in Figures 3 that precipitation has been below the long-term average at the station for eight of the last nine years. Following the very wet year of 2005,

precipitation amounts gradually declined and each of the past three years has been drier than the year that preceded it. The total precipitation recorded at the Salina 24E weather station during the 2007-2008 water year was the lowest ever measured during the 24-year period of operation of the station. It is noteworthy that the very dry conditions measured at the Sufco Mine permit area during 2008 are not entirely reflected in the PHDI for Utah Region 4. This is likely a result of local microclimatic effects in the Southern Wasatch Plateau area that are not reflected in the more general, regional scale climatic trends apparent in the PHDI for Utah Region 4.

5.0 Discussion

On 10 October 2003, prior to undermining in the East Fork drainage, the East Fork monitoring stations were monitored and inspected to document pre-mining conditions in the canyon. The East Fork of Box Canyon Creek was first undermined using full-extraction longwall mining techniques in the 3LPE panel starting in mid November 2003 (Figure 1). Undermining of the East Fork drainage in the 3LPE panel continued as mining progressed southward until early January 2004. Undermining of the upper reaches of the East Fork of Box Canyon in the 4LPE longwall panel began in early 2005 and continued for several months. During November and December of 2005 the middle reaches of the North Water Canyon area were undermined in the 5LPE longwall panel. The last longwall panel in the Pines area (6LPE) was mined during 2006. Mining in the 6LPE panel occurred beneath the headwaters area of the main stem of the East Fork of Box Canyon drainage and in the North Water Canyon area (Figure 1).

It was noted that discharge in the East Fork increased appreciably shortly after the stream was first undermined in late 2003 with the 3LPE longwall panel (Table 1). A similar occurrence was observed at spring Pines 214 (Table 1; Figure 12). This condition was not unanticipated and was likely related to the compression (squeezing) of the aquifer matrix as the stress field associated with the progression of the longwall mining face moved through the area. The effects of this phenomenon are apparent in the hydrograph of stream discharge at monitoring station EFB-11 in Figure 3. It is apparent in Figure 5 that the discharge in the East Fork increased rapidly during November 2003 as mining progressed beneath the area, then declined rapidly during December 2003 and January 2004 as the longwall face passed beyond the region.

It was predicted prior to mining that tension fractures in the East Fork stream substrate would likely have small (less than ½-inch) apertures. Inspection of the stream substrate in 2003-2004, after subsidence related to mining of the 3LPE had occurred, confirmed that this was generally the case. However, it was observed that some buckling of thin- to medium-bedded sandy and silty strata in the channel bottom occurred in the East Fork of Box Canyon Creek overlying longwall mined areas. In these areas, near-surface voids were created in the shallow subsurface along opened bedding planes or occurring between the underlying competent strata and the overlying loose material.

Tension fractures in the East Fork stream channel overlying the 4LPE and 5LPE longwall panels were also observed to have small apertures (generally less than 0.5 inches across).

Other than some moderate bedrock cracking/buckling of a short (~40-foot) section of the

stream substrate immediately above monitoring station EFB-7, tension cracking of the stream channel overlying the 4LPE and 5LPE was relatively minor. Little or no cracking of the East Fork channel substrate overlying the 6LPE panel was observed. This is likely because the East Fork channel is developed mostly on alluvial sediments, which obscure the underlying bedrock in the 6LPE area.

Prior to mining in the East Fork, it was also anticipated that tension cracks in the stream channel would be “dead-end” openings that would not convey surface water out of the East Fork drainage or downward into the Sufco Mine. Based on discharge measurements performed in the East Fork during 2003 and 2004, it is apparent that no significant quantities of surface water were lost from the drainage as a result of longwall mining beneath the East Fork of Box Canyon Creek. Stream discharge data from the East Fork area measured during 2005, 2006, 2007, and 2008 continue to support that conclusion. It is apparent in the 2005 data that discharge in the creek increased appreciably in response to the wetter climatic conditions the region experienced during 2005. During 2006, discharge in the East Fork and nearby springs was somewhat less than that measured during 2005, which is attributable to the considerably dryer climatic conditions the region experienced during 2006 (Figures 2, 3, and 4). During 2007, discharge in the East Fork of Box Canyon Creek was less than that measured during the wetter previous years. This condition is likely a response to the continuous drought conditions the region experienced during 2007. During 2008, in response to the continuing drought conditions the region was experiencing, discharges continued to be lower than the larger flows measured during 2005 and 2006 that occurred in response to the abnormally wet conditions the region experienced in 2005.

In Figure 6, the maximum discharge measured in the creek (station EFB-11, located near the middle of the 3LPE panel) is plotted against the maximum downstream discharge rate below the subsided area (stations EFB-11A, B, or C) for the period 2003 - 2008. It is apparent in Figure 6 that the quantity of water flowing out of the subsided area is similar to the maximum quantity measured upstream in the creek (at EFB-11). During the spring and summer months of 2004, the discharge at the downstream monitoring site was slightly less than that measured above, while in November of 2004 and during 2005 the discharge at the downstream site was greater than that measured above. During 2006 the flow in the stream below the subsidence area was generally similar to the maximum flows measured higher in the stream (Figure 6). During 2007 and 2008, discharge measured downstream of the subsided area (EFB-11B) monitored during the warm summertime months was somewhat lower (approximately 3 to 7 gpm less) than that measured at EFB-11. This condition is likely attributable to losses to evapotranspiration during the warm and dry summer of 2007 and 2008. When monitored during early November 2007 and in late October 2008, after cool temperatures began to dominate in the region and vegetation in the canyon became dormant, the discharge measured below the subsided area was approximately equal (within about 1 gpm greater or lesser) to that measured at EFB-11. That the downstream flow in November 2007 and late October 2008 equaled the upstream flow supports the conclusion that appreciable surface water was not lost in the canyon between these two sites during 2007 or 2008 (i.e. the discharge data are consistent with summertime evapotranspiration losses and are not consistent with the concept of interception by bedrock fractures, which would anticipate diversion of water from the drainage in both summer and fall). Increased flow

rates in streams in the cool fall months relative to those measured during the hot summer months are commonly observed in streams elsewhere in the Sufco Mine permit area (UDOGM, 2009). The very similar nature of the responses measured during 2007 and 2008 also seem to support this conclusion.

Additionally, discharge rates measured at the Sufco quarterly water monitoring station Pines 408 (Lower East Fork at confluence with the main fork of Box Canyon Creek; Figure 1) during 2005 and 2006 were generally similar to the maximum measured up-stream discharge in the creek (EFB-11; Figure 7). This strongly suggests that there was no appreciable or quantifiable loss of water from the East Fork drainage during 2005 and 2006. Discharge rates measured at Pines 408 during the warm summer months of June and early September 2007 were appreciably lower (by about 10 to 14 gpm) than those measured concurrently at EFB-11. This condition is likely a result of appreciable losses of surface water to evapotranspiration during the warm, dry summer months in the long, heavily vegetated reach of the drainage between EFB-11 and the confluence with the main fork of Box Canyon Creek. When the East Fork was monitored during early November 2007 and 2008, after cool climatic conditions began to dominate in the region, and vegetation became dormant, evapotranspiration losses decreased dramatically. In response, the discharge measured at Pines 408 during both November 2007 and late October 2008 exceeded that measured upstream at EFB-11 (Table 1; DOGM, 2009). The observations described above indicate that evapotranspiration losses during the warm summer months are likely responsible for most or all of the variability in discharge rates observed seasonally in the East Fork between EFB-11 and the confluence with the main fork of Box Canyon Creek. Surface water

evapotranspiration losses in creeks have been routinely observed by the author elsewhere in the Wasatch Plateau. There is no indication that significant mining-related impacts to stream discharge rates in this reach of the drainage have occurred.

The fact that groundwater contributions to stream baseflow have occurred consistently at the stream monitoring stations above EFB-11 subsequent to undermining suggests that stream flow was likewise not removed from the drainage in this area (i.e., the groundwater system is discharging water to the stream rather than receiving recharge from the stream). Based on this information, and the fact that the overall discharge in the creek has been generally similar to that observed and measured in pre-mining years, there is no evidence to suggest that appreciable quantities of surface water have been removed from the East Fork drainage as a result of mining-related activities at the Sufco Mine.

It was observed during December 2003 that discharges from three springs located along the base of the Castlegate Sandstone cliff on the northeast hillside above the creek (EFB-12, EFB-13, and EFB-14) ceased. Decreases in discharge from spring Pines 214 were also measured during this time (Table 1). During baseflow conditions in October 2003, the combined flow from the springs was approximately 3.0 gpm (Table 1). Although it was considered unlikely, it had been predicted prior to mining that discharge from these springs could be diverted small distances down-gradient as a result of mining-induced cracking of bedrock near the springs. It is apparent that this phenomenon occurred at these springs.

Although discharge to the surface at these spring locations ceased, new groundwater discharge locations were observed near the stream channel a short distance below and

downstream of the previous discharge locations at about the same time as discharge at the spring locations diminished. Some slumping of saturated colluvial sediments on the steep hillside adjacent to the creek where new groundwater discharge locations were observed occurred shortly after the region was undermined. Continued discharge from the new spring locations and continuing saturation of the colluvial sediments near the stream bank was observed during 2008. This discharge occurs both as measurable discrete spring flow in several locations in this and other nearby locations and also as diffuse discharge to the saturated colluvial sediments on the stream banks and hillsides in the area. Although the total discharge from this system is not readily quantifiable, it does not seem unreasonable to conclude that the discharge is on the order of that previously discharging from springs EFB-12, EFB-13, and EFB-14. It is noteworthy that the baseflow discharge in the creek measured at monitoring site EFB-11 has always been greater than that measured at EFB-10 both before and after the subsidence of the drainage. The measured stream gain in this reach ranged from about 2.2 to 7.5 gpm, averaging about 4.5 gpm (Table 1).

An additional line of evidence suggesting that discharge from the groundwater system that previously supported springs EFB-12, EFB-13, and EFB-14 continues to flow into the East Fork drainage is shown in Figure 8. In Figure 8, discharge measurements from monitoring stations during six selected monitoring events are plotted together with their relative linear distance down the stream channel from EFB-1. Measurements are plotted for the pre-mining baseflow condition (10 October 03), the peak of mining-enhanced discharge in the creek (15 December 03), the early summer of 2004 after a minimal runoff season (25 June 2004), late-season baseflow conditions after repairs to the stream channel (discussed later) had been

performed (2 November 2004), during late spring runoff in a wet year (1 June 2005), during baseflow conditions in a wet year (27 October 2005), during late spring runoff in a moderately wet year (19 May 2006), and during baseflow conditions of a moderately wet year (31 Oct 2006). Discharge during early summer drought conditions (24 June 2007 and 13 June 2008) and late fall drought conditions (6 November 2007 and 31 October 2008) are also plotted on Figure 8. It is apparent in each of these plots that discharge rates in the East Fork generally increased downstream from EFB-6 to EFB-11 (which corresponds to the area of spring discharge from near the base of the Castlegate Sandstone). If the groundwater system that provided baseflow to the creek and supported springs EFB-12, EFB-13, and EFB-14 was drained (i.e., the groundwater was diverted downward into the mine or laterally into another drainage) measurable groundwater contributions to baseflow discharge to the creek would not be anticipated. That the stream continues to gain water through this reach under all seasonal and climatic conditions at magnitudes similar to those measured before mining supports the conclusion that only the discharge locations of the impacted springs have been moved, and dewatering of the groundwater system has not occurred.

When the East Fork drainage was visited early in the spring of 2004 (29 April 2004), it was noted that several short reaches of the creek were dry. The lengths of the dry reaches varied from a few feet to a few hundred feet. Because the stream drainage was mostly covered with snow during the December 2003 and January 2004 monitoring events, it was not known whether the dry reaches of the creek existed prior to April 2004 or whether they had occurred more recently. As discussed above, it has been demonstrated that surface water was not being diverted into deeper geologic formations or into the Sufco Mine openings, nor was it

being redirected to adjacent surface water drainages. It is noteworthy that the dry stream reaches were primarily observed in the Blackhawk Formation where thin- to medium-bedded silty sandstone rocks were exposed in the bottom of the stream channel. Where these bedded sedimentary rocks are exposed at the surface in areas that experienced subsidence fracturing and high geologic stresses, the sandstones tended to buckle or break along horizontal bedding planes. This resulted in loose slabs of rock lying on top of more competent rock in the stream channel. The buckling of the thin-bedded strata likely occurs primarily near the surface where there is little vertical confining pressure on the rocks. In deeper horizons where there is vertical confining pressure, the buckling of the rocks is likely much less intense, and fracture apertures (through which water can travel through the subsurface) are likely small. During periods of low flow in the East Fork, surface water was observed flowing beneath the loose, broken rock strata in the shallow subsurface, leaving the overlying channel surface dry. Surface water was also observed flowing through tension fractures that were largely oriented parallel or sub-parallel to the direction of the stream flow. It is likely that movement of surface water through both the loose, buckled, bedded sedimentary strata and through the tension cracks was limited to the shallow sub-surface. This conclusion is supported by the fact that the dry stream reaches were typically relatively short in length, with generally only a few feet to a few tens of feet of topographic elevation difference between the upper and lower extents of the dry reaches. Typically, surface water re-emerged in the stream drainage where the first or second low-permeability shaley horizon intersected the channel bottom. If the surface water beneath the dry stream reaches were migrating through deep strata, it would be anticipated that the lengths of the dry reaches would be

longer (i.e., the surface water would re-emerge farther downstream at lower topographic elevations).

The conclusion that the water flowing beneath the dry stream reaches was moving through the shallow subsurface is also evidenced by observations at ledges and waterfalls in the East Fork drainage. At many such locations, water was observed discharging from the waterfall or ledge only a few inches to a few feet below the top of the ledge (Figure 9).

Beginning on 21 September 2004 and continuing to 5 October 2004, repairs were made to the stream channel in the East Fork to restore continuous surface water flow to the dry stream reaches. In some locations, this was accomplished simply by removing the loose, buckled, rocks from the channel substrate, revealing the surface flow beneath. In other locations, this was accomplished by placing bentonite in the stream channel in tension cracked zones.

These repairs were successful in restoring surface water flow in essentially all of the stream reaches in the East Fork channel subsided by the mining of the 3 Left Pines East panel.

When the East Fork drainage was monitored on 2-3 November 2004, it appeared that stream flow in the drainage was continuous, although portions of the drainage were obscured by snow and ice cover. Discharge measurements and site observations made during 2005 confirmed the presence of continuous, substantial discharge in the stream from EFB-7 to the confluence with the Main Fork of Box Canyon during all 2005 site visits. Likewise, there was no indication of any downstream diminution in creek discharge that would indicate that surface flow was being diverted into the subsurface.

During the springtime of 2006, discharge in the East Fork appeared to be continuous from EFB-7 to the confluence with the main fork of Box Canyon. Zones of visibly diminished flow were not apparent anywhere in this portion of the drainage. Overall, discharge rates measured in the East Fork during 2006 were somewhat less than those measured during 2005 (Table 1). This condition would be anticipated as a result of the substantially dryer climatic conditions experienced in the region during 2006 (Figures 2 and 3).

It should be noted that although the stream sediments at EFB-6 were saturated, no discharge was measured at EFB-6 during 2006, 2007, or 2008. As discussed previously, perennial stream flow in the East Fork historically began at or near EFB-6. Historically, for several hundred feet above this location the stream channel was usually dry (a few wet spots were sometimes present in intermittent locations in the East Fork above EFB-6). Historically, commencing at EFB-6 the stream gradually increased rapidly in flow at downstream locations. During both 2006 and 2007, although there was no flow at the EFB-6 monitoring point, perennial flow began about 40 to 50 feet below EFB-6 and the stream gained rapidly downstream from that point in a manner similar to that occurring in previous years. During June of 2008 a flow of about 0.1 gpm was observed in the channel a short distance below EFB-6. During the remainder of 2008, no flow was measured between EFB-6 and EFB-7, although much of the channel bottom in this reach was covered with substantial deposits of sand that were transported down the canyon and emplaced as a result of recent torrential thunderstorm events.

The change in the location of the first emergence of stream flow in the reach between EFB-6 and EFB-7 is likely attributable to changes in the shallow groundwater system resulting from subsidence of the area. This occurrence may also be related in part to the dry climatic conditions the region has experienced in recent years (Figures 2 and 3).

On 19 July 2006, a torrential thunderstorm event occurred in the East Fork drainage. On that date, precipitation measured at Sufco's East Fork Weather Station located adjacent to EFB-2 totaled 1.17 inches in a two-hour period. Based on field observations subsequent to the precipitation event, it was apparent that the discharge was focused in the North Water Canyon area and that a surface-water discharge several feet deep rushed down North Water Canyon and subsequently down the main stem of the East Fork to the confluence with the main fork of Box Canyon. There was no indication of a torrential flood of water in either the East Fork above EFB-6 or in the main fork of Box Canyon above Pines 407. Upon inspection of the East Fork drainage below EFB-6 subsequent to the storm, it was readily apparent that substantial changes to the stream morphology in the stream had occurred. In many locations, alluvial and colluvial sediments and associated vegetation underlying and directly adjacent to the stream were eroded away, leaving a bare, exposed bedrock channel substrate. Additionally, in some areas where loose or highly weathered bedrock was present in the stream substrate, this material was removed by the torrential stream flow leaving significantly altered stream channel configuration. Photographs of the East Fork stream channel after the torrential precipitation event are shown in Figure 10. An additional torrential precipitation event was recorded at the East Fork Weather Station on 5 October 2006, with a measured rainfall of 1.79 inches in a 24-hour period.

Subsequent to the torrential precipitation events, discharge rates in the East Fork were monitored on 31 October 2006. Discharge rates measured at this time were generally consistent with the climatic conditions in the region at that time (Table 1; Figures 2 and 3). However, the discharge rate measured at EFB-9 was somewhat lower than anticipated (about 4.6 gpm lower than EFB-8). Additionally, a reach of dry stream substrate about 50-75 feet in length was observed a short distance above EFB-10 in October 2006. This condition is likely attributable to changes in the stream channel morphology resulting from the torrential thunderstorm events (which were substantial at EFB-9). Additionally, the bentonite repairs performed to the stream channel by Sufco personnel in this vicinity during 2004 may have been compromised by the runoff event. However, it is important to note that the overall stream flow gain between EFB-6 and EFB-11 measured at that time is consistent with that anticipated for the climatic conditions. Additionally, the downstream discharge measured at Pines 408 (28.7 gpm; UDOGM 2009) is greater than the maximum upstream discharge measured at that time, strongly suggesting that no net-loss of water from the drainage occurred. During 2007, discharges measured in the creek during each of the three monitoring events were somewhat lower than those measured during 2006. This condition is likely attributable to the drought conditions the region experienced during 2007. It should be noted that during 2007 a few sections of the stream channel between monitoring sites EFB-9 and EFB-10 (ranging from a few tens to several tens of feet in length) did not contain flow at the surface. While there was commonly some minimal wetness on bedrock surfaces and in the unconsolidated sediments along stream banks in most of these reaches, measurable stream flow at the surface was not present. The dry stream reaches observed during 2007 in

these areas are likely a result of the diversion of surface water into shallow fracture pathways with subsequent migration of the stream water downstream through the shallow subsurface beneath the stream channel. The existence of these shallow flow pathways through the subsurface suggests that the channel repairs performed previously in the East Fork were compromised to some extent in that location. The diminished functionality of the channel repairs is most likely attributable to the channel scouring events associated with torrential precipitation events that occurred during 2006 described previously, which removed appreciable amounts of both loose bedrock and unconsolidated sediments from the drainage.

The fact that the stream discharge measured during 2007 short distances downstream of these dry stream reaches was equal to or greater than that measured above, and the fact that no downstream losses of surface water were noted during 2007 (other than the previously described evapotranspiration losses) strongly suggest that there was no loss of surface water from the drainage during 2007.

During 2008, discharge in the East Fork was observed to be continuous from EFB-7 to the confluence with the main fork of Box Canyon Creek. Diversions of any substantial portions of the stream flow into the subsurface beneath the stream channel were not noted. The stream flow conditions observed in the channel did not appear substantially different from those observed prior to the undermining of the drainage.

For comparative purposes, plots of the yearly baseflow (October or November) discharges measured at each of the East Fork stream monitoring station for the period 2003-2008 are

presented in Figure 11. It is apparent in Figure 11 that the fall baseflow discharges for all years other than 2004 (which was shortly after subsidence had occurred and before channel repairs were performed) were similar to or greater than those measured in the pre-mining baseline survey in October 2003. It is noteworthy that the most recent baseflow discharges measurements performed during October 2008 are very similar to those measured in the October 2003 pre-mining baseline survey. Both the October 2008 and October 2003 measurements were performed during periods of drought.

Prior to the undermining and subsidence of the spring area, discharge from Pines 214 averaged about 2½ gpm (June 2001 through October 2003; Figure 12). Coincident with the undermining of the spring area, discharge from the spring briefly surged to 37 gpm, then declined to as little as 0.08 gpm in June 2004 after mining in the area was complete. It is noteworthy that discharge from spring Pines 214 increased steadily from 0.09 gpm in August 2004 to 0.87 gpm in October 2006. The fact that groundwater discharge continues to occur from the groundwater system supporting the spring indicates that the Castlegate Sandstone groundwater system continues to operate (i.e. groundwater in the Castlegate has not been dewatered or diverted into deep horizons). Discharge from Pines 214 continued during 2007, although the discharge rate from the spring was somewhat lower than that measured in 2005 and 2006 (Figure 12). The discharge measured during 2008 was somewhat greater than that measured during 2007. It should be noted that the established historical monitoring point for Pines 214 is situated immediately below a sandstone ledge several tens of feet below the spring discharge location. Subsequent to the undermining of the spring area, the sandstone ledge over which the spring discharge flows before reaching the monitoring station was

cracked. Consequently, some of the spring discharge is diverted into the bedrock or colluvial sediments immediately upstream of the monitoring point and this discharge is not included in the discharge value reported to the Division of Oil, Gas and Mining for spring Pines 214 (this discharge likely flows diffusely into the East Fork stream channel about 30 feet below the monitoring point). For the purpose of obtaining a more representative spring discharge measurement, discharge from Pines 214 has also been measured immediately above the sandstone ledge (about 40 feet higher in the drainage) since 2006. It is apparent in Figure 12 that the discharge from Pines 214 measured during drought conditions in 2006, 2007, and 2008 (averaging 1.22 gpm) is approaching that of pre-mining levels.

Discharge from spring EFB-8, which also discharges from the Castlegate Sandstone does not appear to have been detrimentally affected by mining-induced subsidence and continues to discharge at rates consistent with the prevailing climatic conditions (Figure 13). It is notable that during 2007 and 2008, discharge rates measured at EFB-8 spring were essentially identical to those measured during 2003 before the region was undermined.

As discussed above, discharge data from the East Fork stream channel above EFB-6 indicate that the East Fork drainage is usually mostly dry above EFB-6. During 2003 and 2004, all monitoring stations above EFB-6 were dry, with the exception of a small discharge (~0.5 gpm) measured at EFB-4 (Table 1). Discharge near EFB-4 was typically present for a distance of several tens to hundreds of feet above or below the EFB-4 during 2003-2004. Additionally, during 2003-2004 there were a few localized muddy/damp zones a few tens of feet in length present between EFB-5 and EFB-2. During 2005, 2006, 2007, and 2008, no

discharge was measured at EFB-4, although wetness was noted in the channel in some nearby areas. Stream flow in the poorly defined stream channel above EFB-2 was not observed prior to 2008, nor was it observed in 2008. It should be noted that a groundwater seepage area near EFB-1 that contributed water to Joes Mill Pond ceased to discharge at the surface after subsidence of the area occurred. Prior to the undermining of the region, this seep consisted of a damp hillside with diffuse seepage into muddy soils adjacent to the pond. Discrete discharge that could be measured from this seep rarely occurred prior to undermining.

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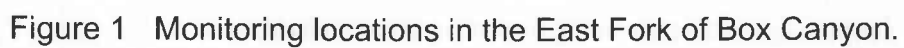
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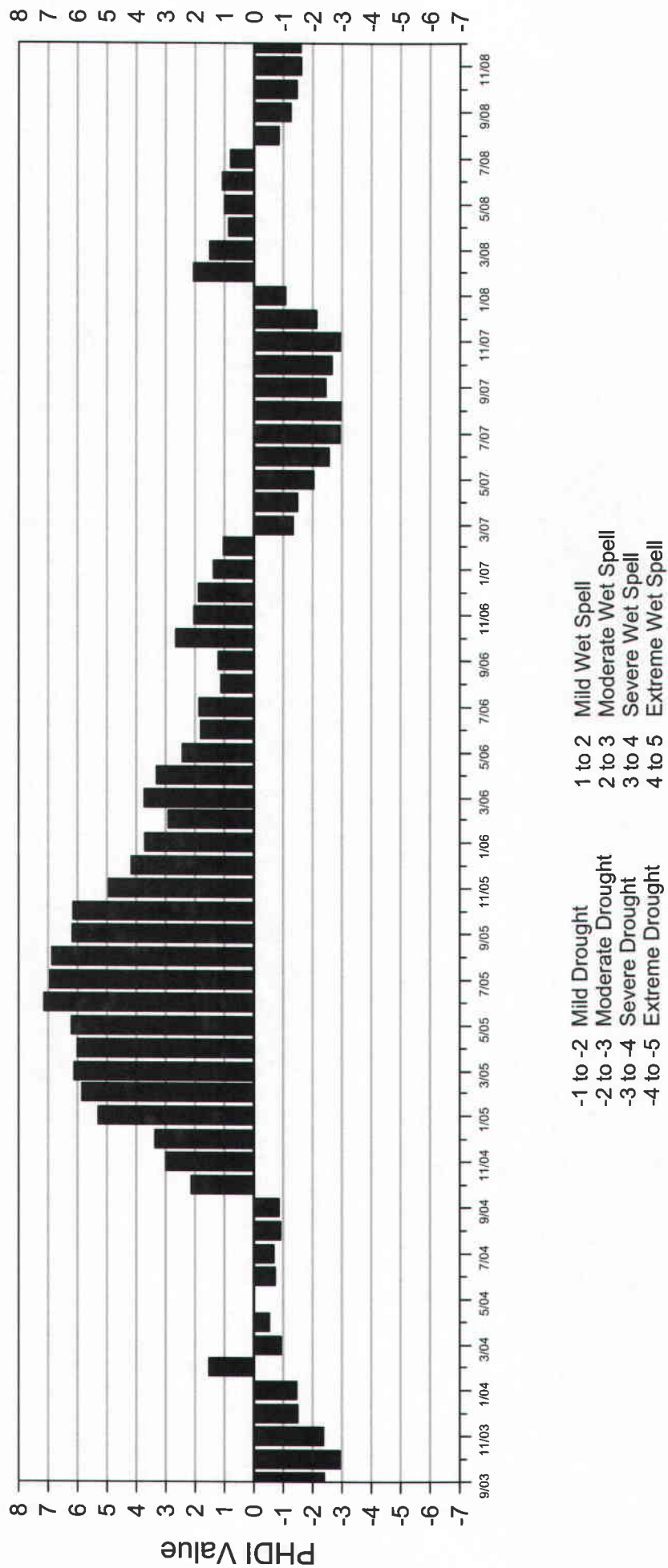


Figure 2 Plot of Palmer Hydrologic Drought Index for Utah Region 4.

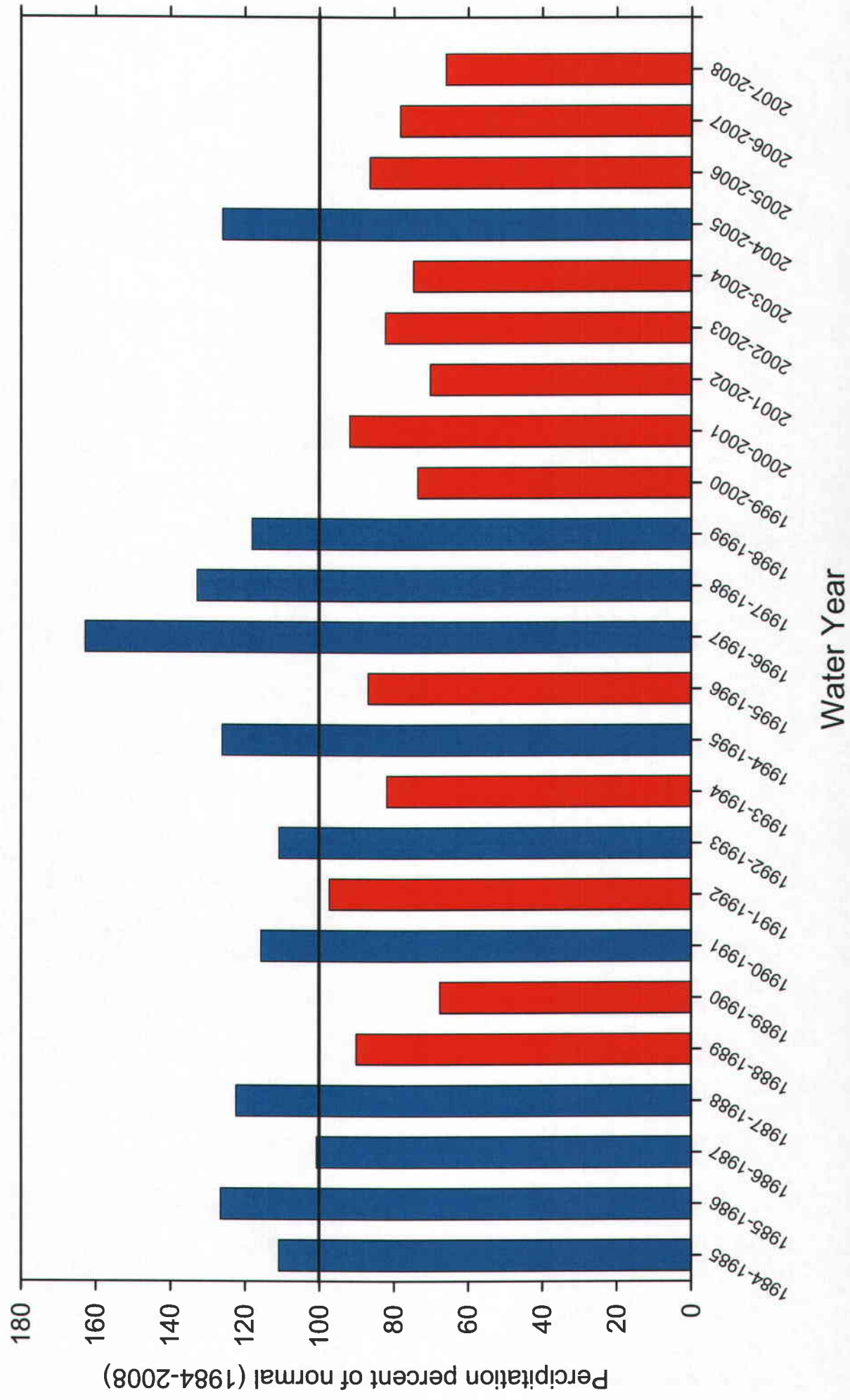


Figure 3 Sufco Mine Weather Station Precipitation percentages of normal (2003-2008).

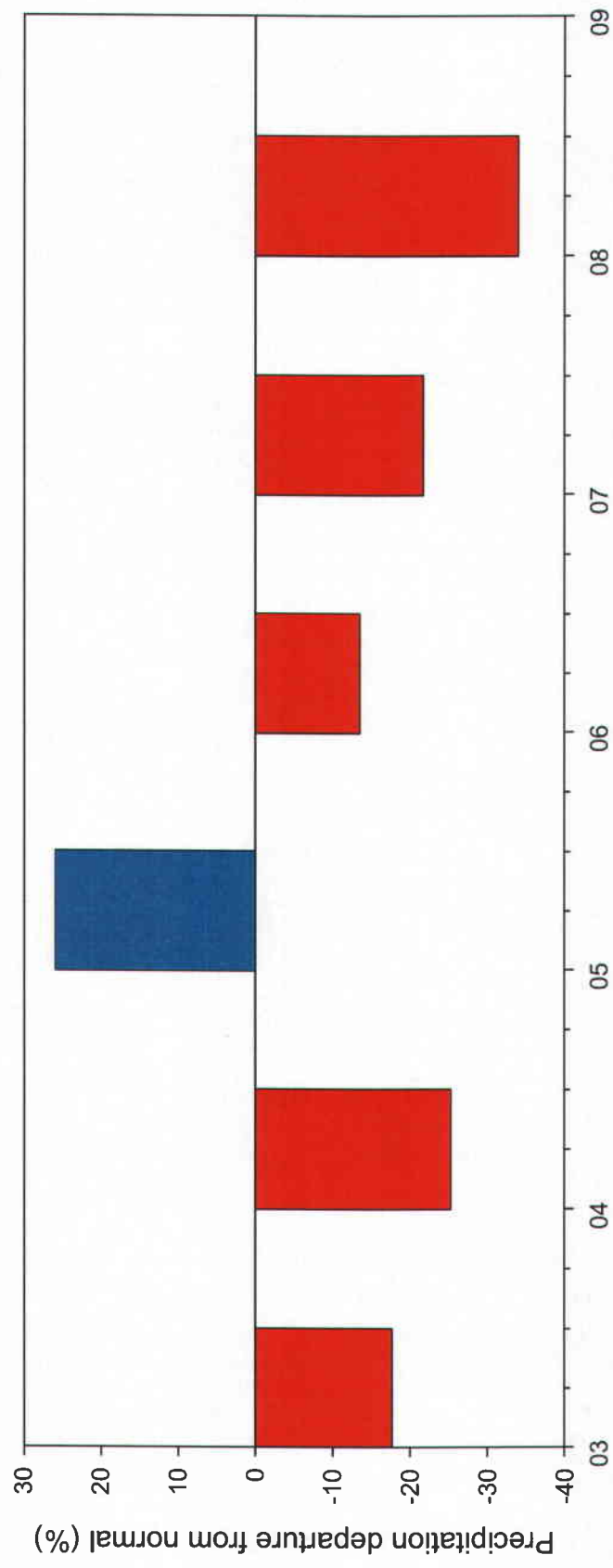


Figure 4 Plots of precipitation departures from normal at the Sufco Mine weather station (Salina 24E) 2003-2008.

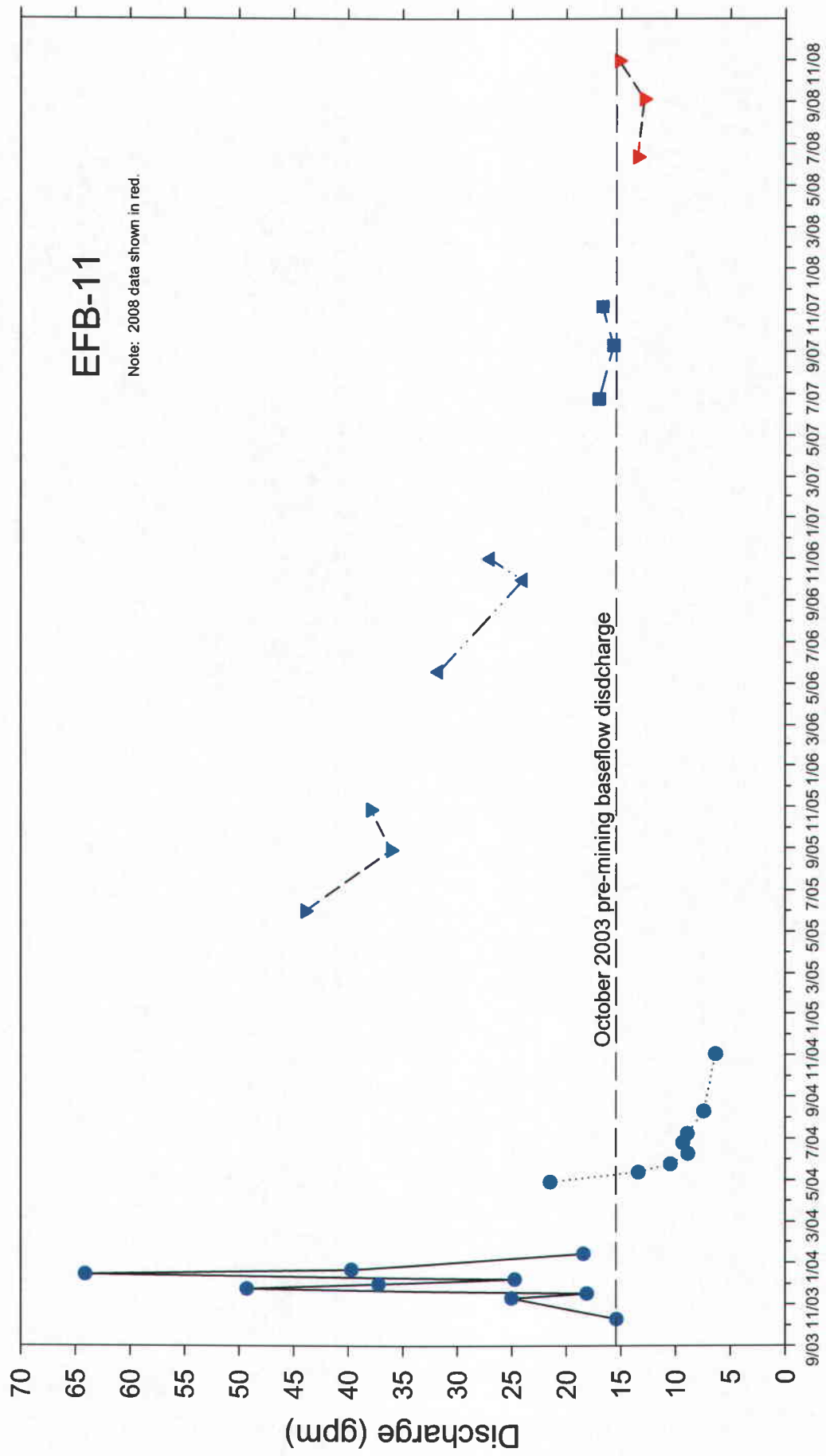


Figure 5 Discharge in the East Fork of Box Canyon Creek at monitoring station EFB-11.

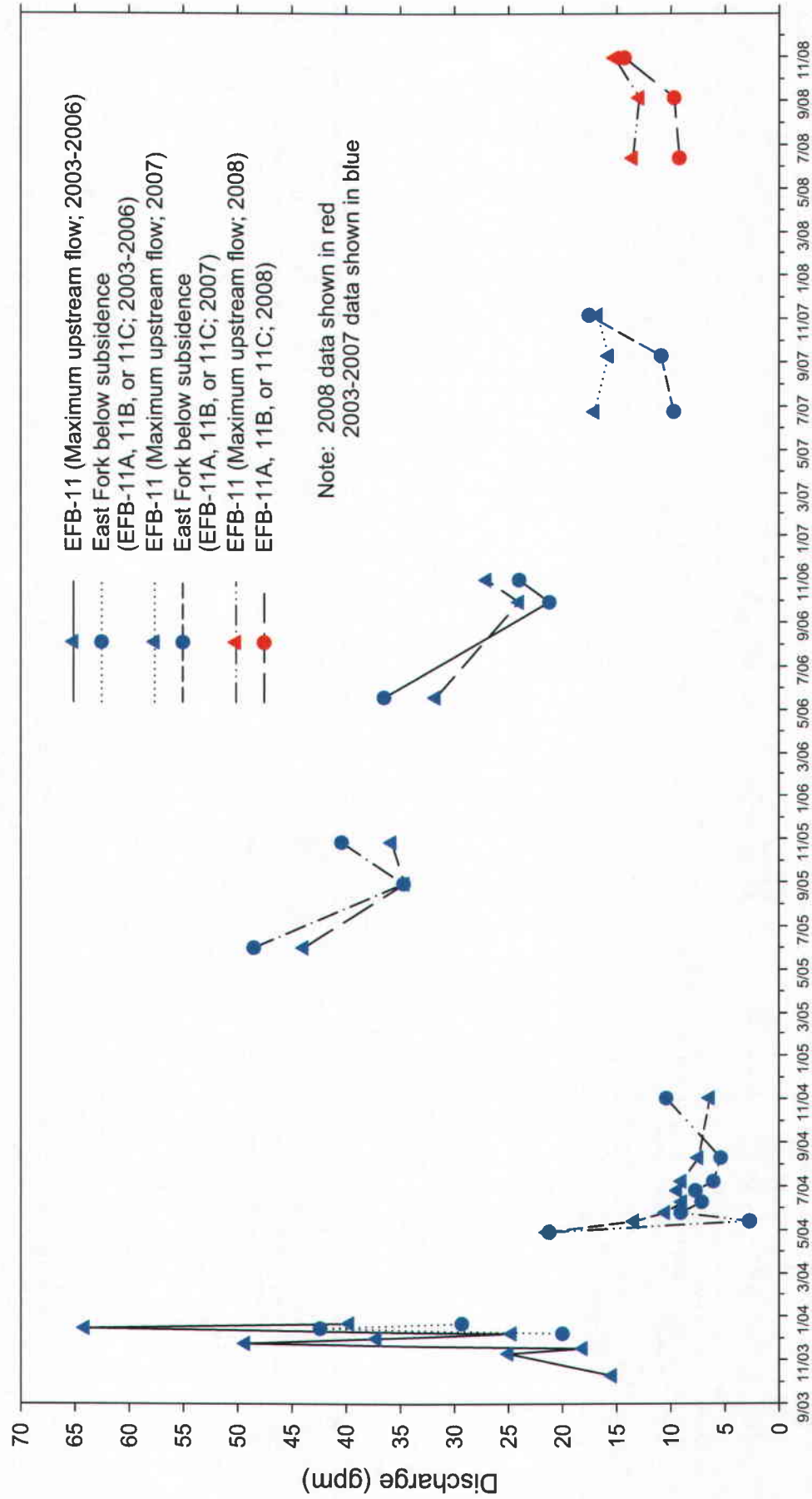


Figure 6 Comparison of maximum discharge in the East Fork of Box Canyon Creek with maximum discharge in the creek below the subsided area.

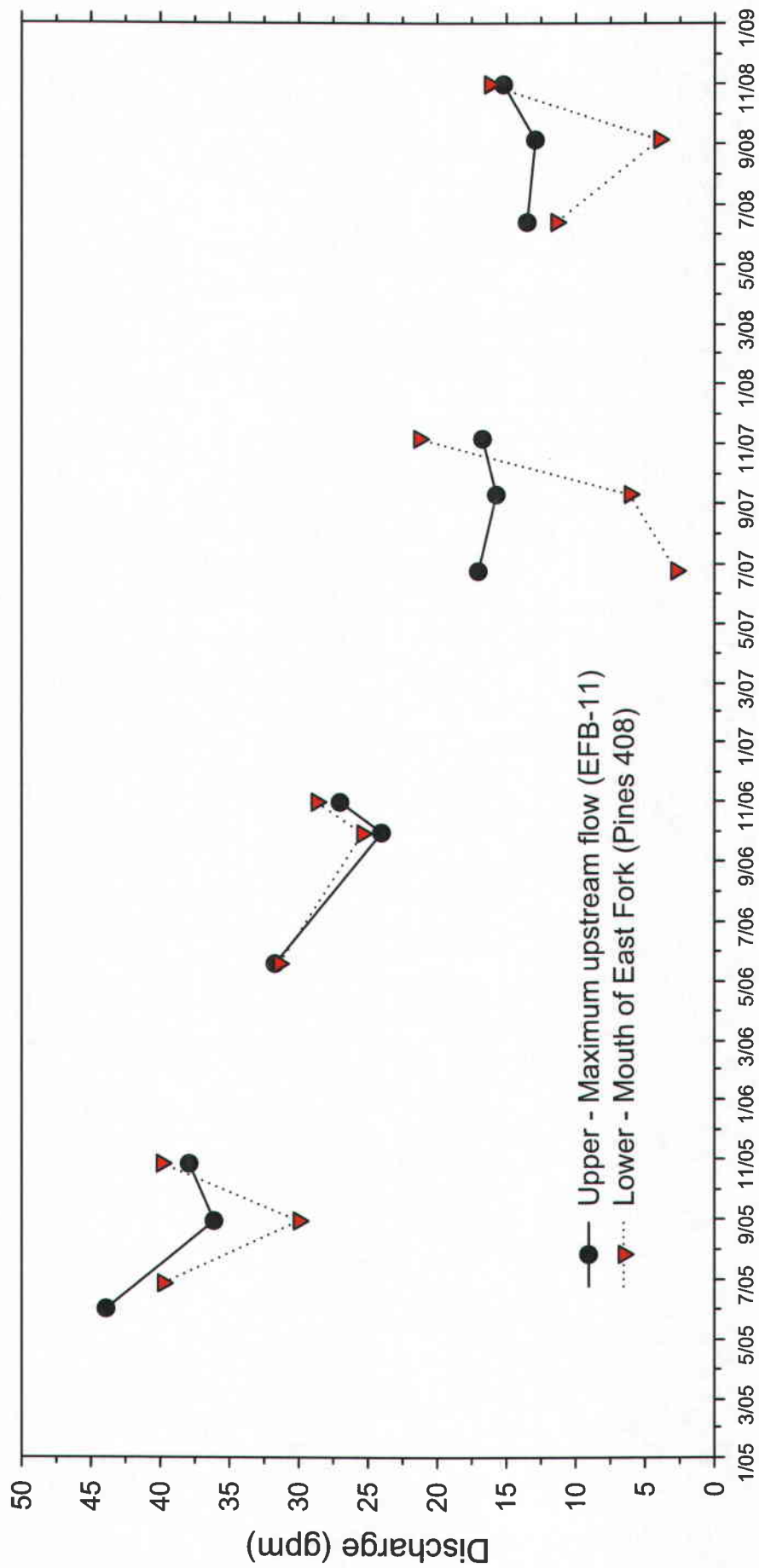
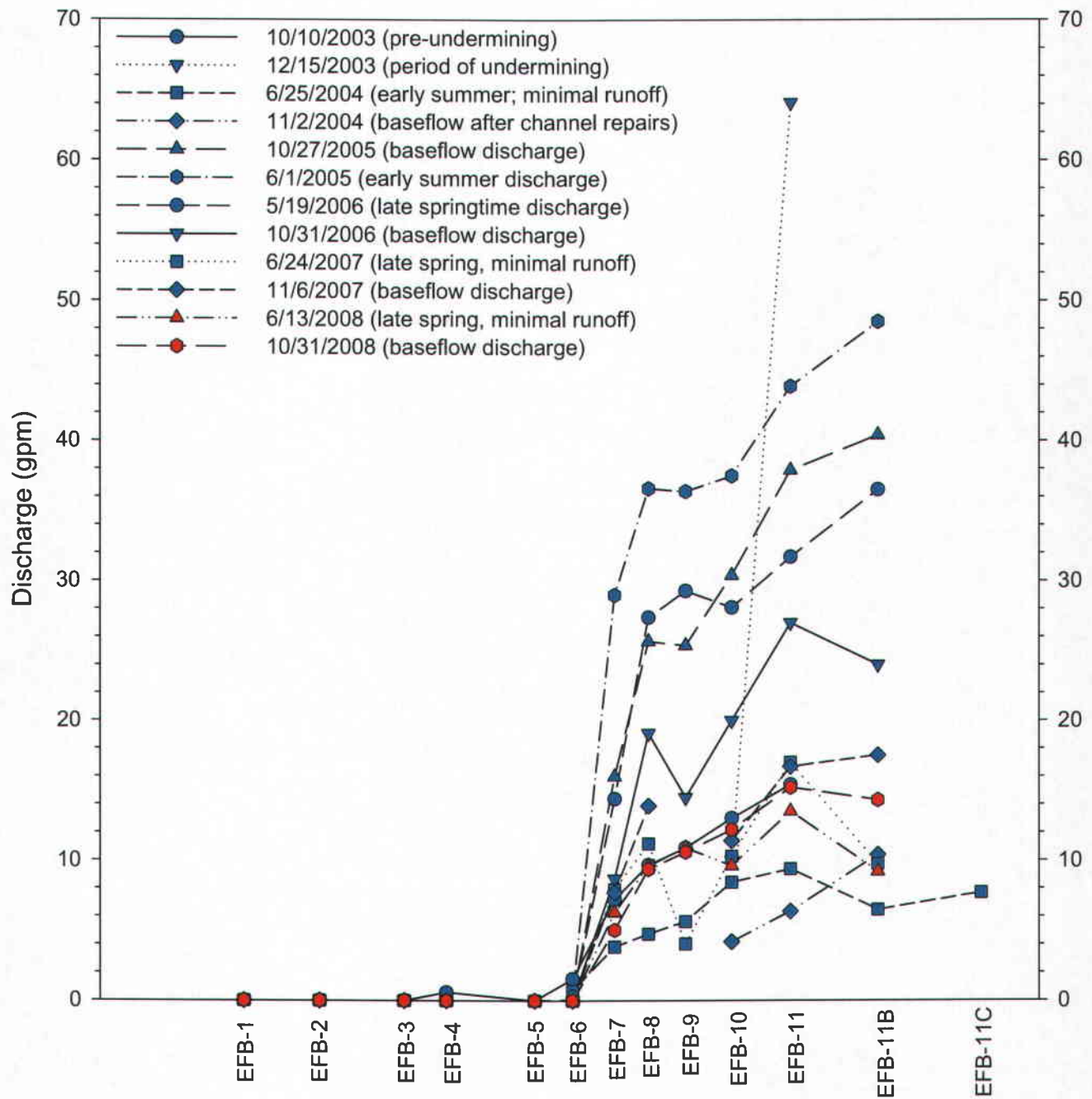


Figure 7 Comparison of maximum upstream flow in the East Fork of Box Canyon with discharge at the lower mouth.



Note: 2008 data shown in red.
Discharge data from EFB-11A not shown on graph.

Figure 8 Plots of discharge from East Fork of Box Canyon Creek monitoring sites.



Figure 9 Waterfall in the East Fork of Box Canyon near EFB-11.



Stream channel at EFB-8

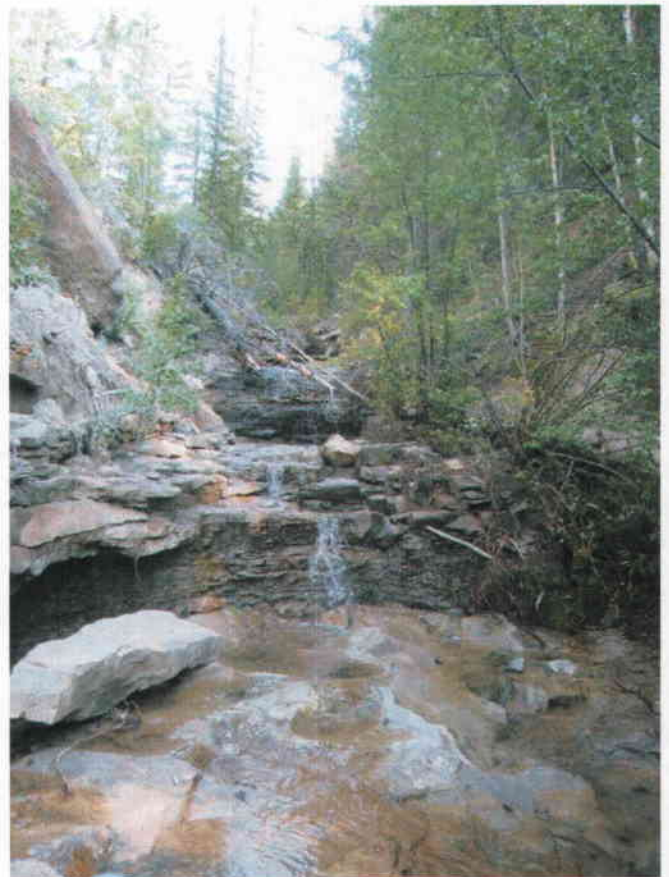


Stream channel below EFB-11

Figure 10 Photographs of the East Fork stream channel after the 19 July 2006 torrential thunderstorm runoff event.



Stream channel below EFB-11



Stream channel below EFB-11



Stream channel near EFB-11A

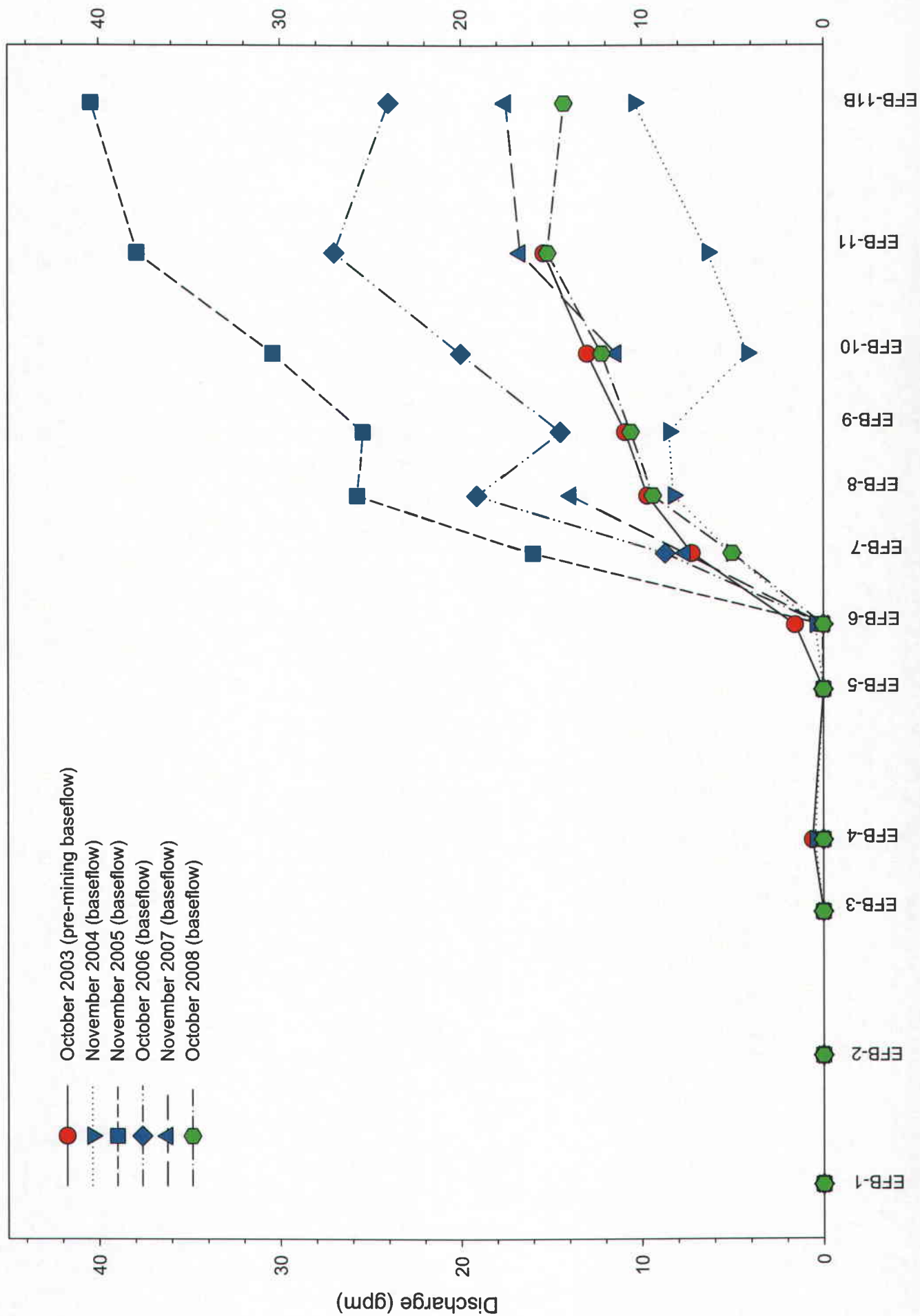


Figure 11 Plots of baseflow discharge for East Fork Box Canyon Creek monitoring stations (2003-2008).

Pines 214

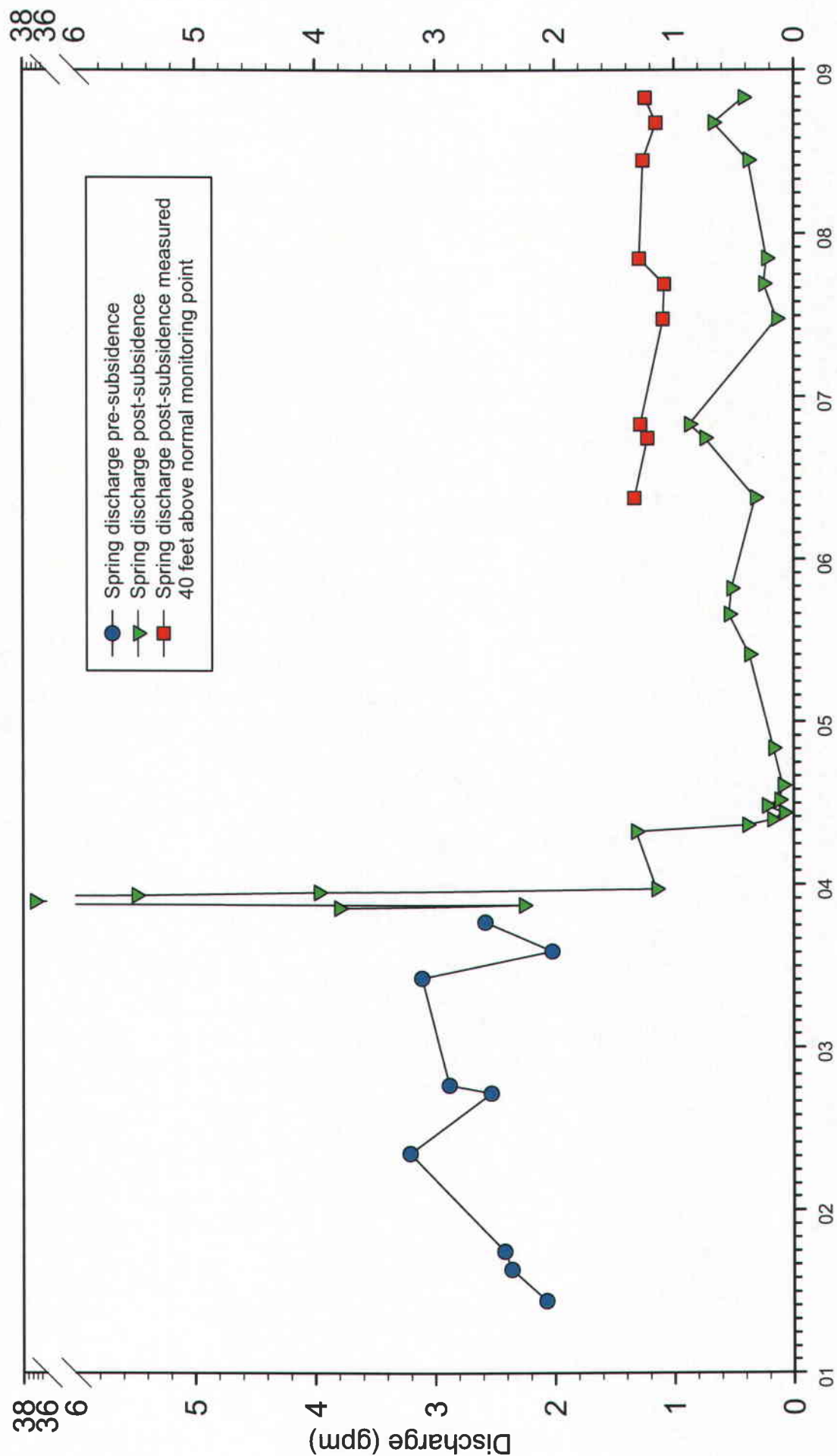


Figure 12 Discharge hydrograph for spring Pines 214.

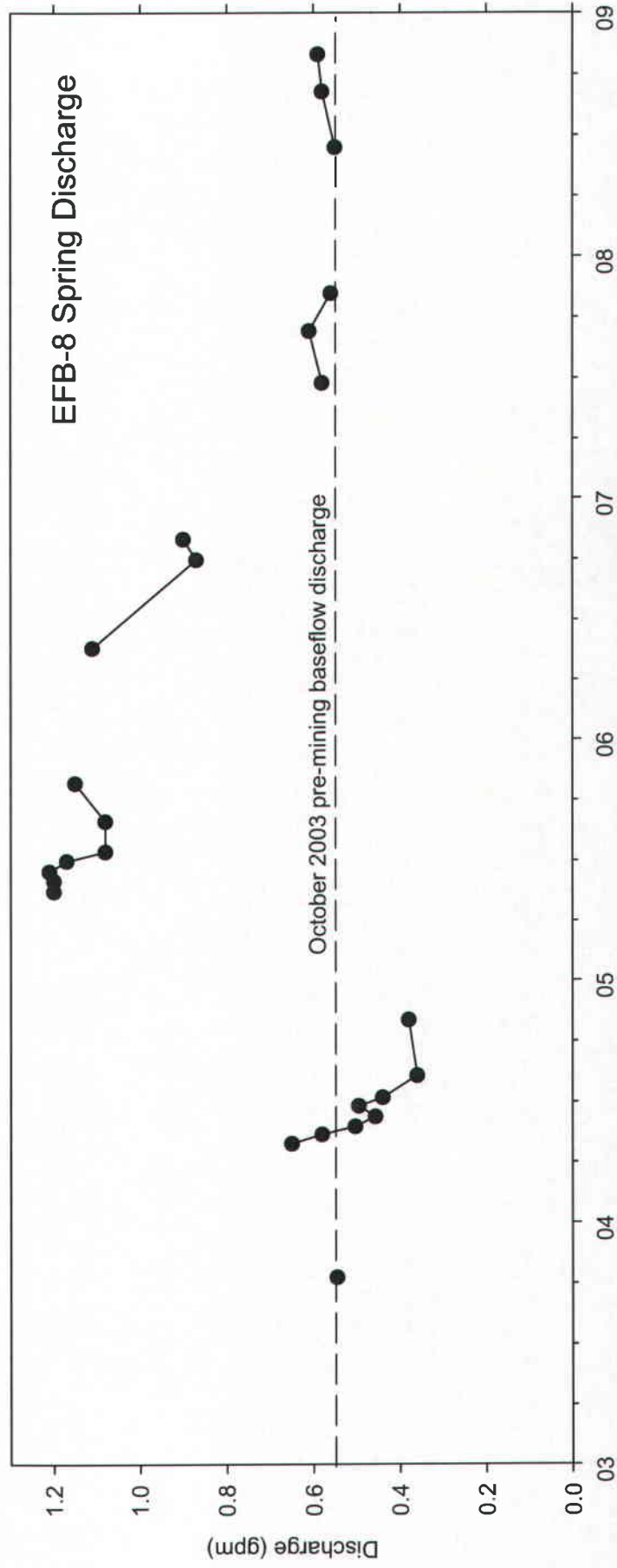
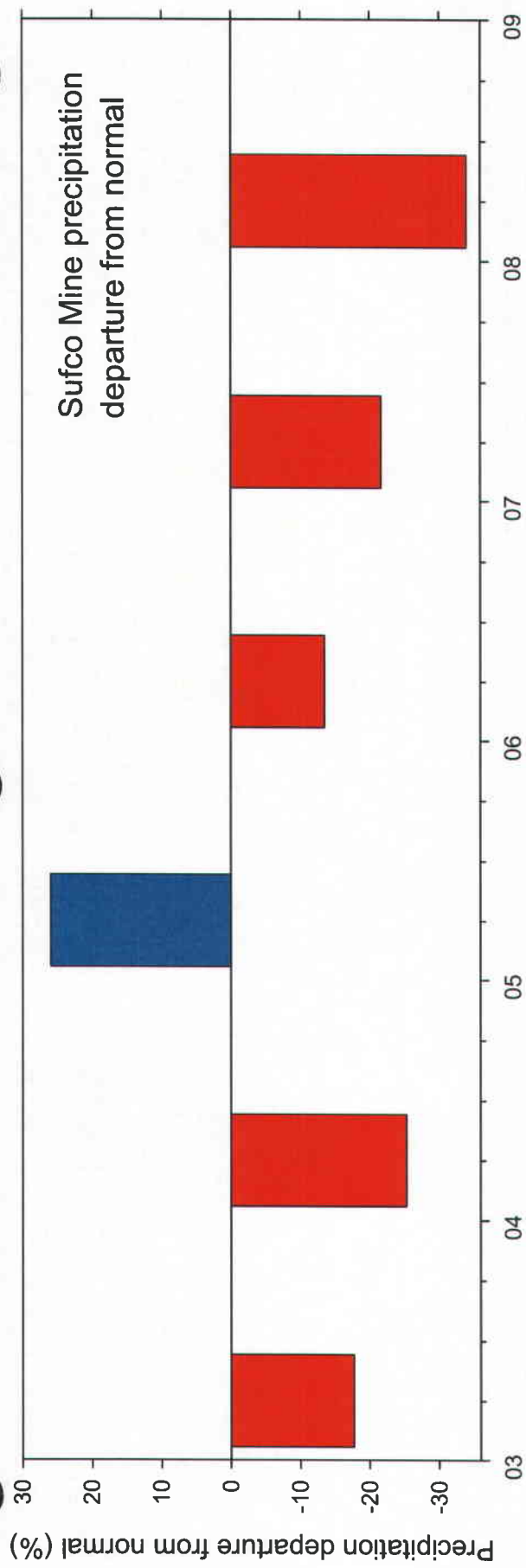


Figure 13 Plot of EFB-8 spring discharge and Sufco Mine precipitation departure from normal.

APPENDIX C

Legal Financial, Compliance and Related Information

Annual Report of Officers
As submitted to the Utah Department of Commerce

Other change in ownership and control information
As required under R645-301-110

CONTENTS

Submitted in Canyon Fuel Company, LLC General Chapter One

APPENDIX D

Mine Maps

As required under R645-302-525-270

CONTENTS

Annual Mine Subsidence Map
Mining Progress Map 2008

APPENDIX E

Other Information

In accordance with the requirements of R645-301 and R645-302

CONTENTS

None